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INVESTIGATIONS ON THE ACTION OF LUMINOUS RAYS AND THEIR MODE OF ACTION*

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Almost everywhere at the present time time when the light bath is spoken of in therapeutic reference, the short wave ultraviolet rays are thought of, so that one is inclined to think that the effect of the light bath is essentially, if not perhaps exclusively due to these rays. As to the effect of light on rickets and related diseases, there is no doubt that the ultraviolet rays are the effective ones. But as to the effect of light on other diseases, especially tuberculosis, there are no such decisive proofs, and there we must reckon with the possibility that also other ranges of rays, namely the luminous rays, may be of a more or less decisive importance.

The following problem has been discussed for many years: What is the active agent in light in the therapeutic bath? Light has two different effects on the organism, a chemical effect which shows itself in the slowly appearing erythema, the pigmentation, etc., and a heat effect. The two effects are very simply distinguished by saying what is not heat effect is a chemical effect. Light has, therefore, no other effects on the organism but these two. There are no other possibilities. We now know by experience that a heating, especially a simple radiation with heat, is not nearly of the therapeutic importance on surgical tuberculosis as the generally employed light bath; it is thought that from the very first it is out of the question that the heating effect of the light could be of any importance with the light bath, and there remains nothing else but that the whole effect must be of a so-called "chemical character."

It shall be my object in this paper to show you that this opinion cannot be maintained. The heating which luminous rays are able to give us is of a different kind than any other heat radiation and is absorbed by the organism in a quite specific manner which possibly may be of a very great therapeutic importance. Before I start showing the reason for this, I shall say a few words as to the physical relations between the luminous rays and the general heat rays, and as to the kind of rays which are emitted by our generally known sources of light.

The spectrum of light makes but a very little part of the very large heat spectrum. With suitable prisms all heat rays may be divided into a long series with various wave lengths which reach up to the longest known on the one hand, namely about 10,000$\mu\mu$ and on the other hand, the shortest known, about 100$\mu\mu$. A very little range, from about 700$\mu\mu$ to about 400 $\mu\mu$ of this large spectrum has been quite promiscuously termed "light spectrum" because of its

[A series of experiments show the capacity of luminous rays to cause a specific warming of the blood in and under the surface of the skin illuminated, without simultaneously increasing the universal temperature of the body. No other action of heat on the organism has a similar effect. The possible great therapeutic value of this is discussed and demonstrated. It is still impossible, in many cases, to say whether the effect of light baths is due to the irradiation with ultraviolet rays, with luminous rays, or with a combination of both.—Carl Sonne, M. D., Copenhagen, Denmark.]

*Read at seventh annual meeting, American College of Physical Therapy, Chicago, Oct. 12, 1928.

effect on the human eye. The region of rays consisting of waves that are longer than the longest visible rays are called infra-red and the region of rays that are shorter than the visible rays are called ultraviolet. But in reality all three regions form an uninterrupted series of different wave lengths.

By means of the heat rays, energy is radiated. The light rays should be conceived as visible heat rays and the remainder of the heat rays, that is what in every day talk are termed heat rays (namely infra-red rays and ultraviolet rays), as invisible heat rays. The visible and invisible heat rays are thus totally homogeneous in respect to their power of radiating heat.

But on the other hand, there is a great difference between visible and invisible heat rays in respect to the way in which they are emitted and absorbed by colored objects, as well as of their power of penetration through various media.

When a colored object, for instance blood, is struck by white light, the portion of light which gives color to the object is reflected, while the rest is absorbed. Quite different rules for reflection apply to the invisible heat rays, rules which are in part still unknown to us.

As to the penetrating power of the two kinds of rays, I would draw your special attention to the fact that the luminous heat rays pass almost unweakened through clear media, for example water, while such media to a considerable extent absorb the invisible heat rays. Ice, for instance, is melted if it is irradiated with invisible heat, while the visible heat rays can pass straight through the ice without melting it. If, for example, a lens is made of ice, a substance may, by means of the luminous rays, be ignited in the focus without these luminous rays having had any effect on the ice in passing through it.

Our generally employed sources of light emit light because they have been heated so much that they have become glowing hot and thereby luminous. The higher the temperature they have been heated to, the more light does the heated medium emit. But besides the luminous heat rays such light emitters also emit large quantities of invisible heat rays, even the greater part are invisible heat rays. The sun has a very high temperature, it is strongly incandescent. The light from the sun is, therefore, very rich in visible rays in proportion to the infra-red ones, as the energy of the latter at the surface of the earth is hardly double that of the former. Thus there is a considerable quantity of invisible heat rays in sunlight also. But it is much more unfavorable for the most "earth made" light emitters. The visible radiating energy of a carbon arc lamp generally does not exceed 15 to 20 per cent of the total radiating energy and as to weaker sources of light the heat equivalent for the luminous rays is really quite trifling. For the electric incandescent lamp it is only about five per cent and for the oil lamp and the like only two to three per cent. Circumstances with the quartz mercury lamp are somewhat different. The glowing mercury vapors here only emit visible rays of light and invisible ultraviolet rays, and as good as no infra-red rays at all. The proportion between the radiating energy for the visible and the ultraviolet rays from the quartz mercury lamp is about one to one.

What I would ask you to particularly note is that the three light emitters most employed in light therapy, namely, those which emit the most ultraviolet rays—the sun, the carbon arc lamp and the mercury quartz lamp—also emit the most luminous rays. From the kind of the effective light emitters we therefore can not decide in advance that it is the ultraviolet rays which are solely active in light therapy.

I shall hereafter come to a more detailed description of my investigations on the specific biological influence of the luminous heat rays on the organism.

Many years ago, namely in 1894, Rubner showed that one can bear a large quantity of radiated heat on the surface of the skin, if the rays transmitting the heat are luminous rays than if they are invisible rays. He investigated this question from an economical, practical point of view to ascertain what kind of light emitters it would be more advantageous to use for illumination and he did not enter on the biological part of these observations at all. Light biologists have in several decades left this fact unnoticed.

In reality the proving of this fact is indeed of extraordinarily great interest for the light biologist, and as I, in my time, noticed this old work by Rubner, I immediately began to examine this more closely with the following experiments to find out why this was the case, and what importance it might have as a contribution towards explaining the therapeutic effect of the light bath.

The first thing I did was to get an exact measure of how many calories of radiant heat one could bear radiated on to the skin without being burned by luminous rays, by outer infra-red rays and by inner infra-red rays. It was soon found advisable to differentiate between inner and outer infra-red rays. The inner are those which lie closest to the luminous rays in the spectrum and the outer are those which lie to the extreme left in the spectrum. Substances which are only moderately heated almost exclusively emit outer infra-red rays. They have only an extremely slight penetrating power. Even a screen of the thinnest glass or a thin water screen is sufficient to protect from the heat of a warm stove. The inner infra-red rays, but chiefly the luminous rays have a greater penetrating power.

I obtained the inner infra-red rays by sending an electric current through a resistance coil of suitable size whereby it was heated until it could not be seen to be glowing at day light.

Visible heat rays I obtained from a carbon arc lamp, the rays of which, for the purpose of filtering off the infra-red and the ultraviolet rays were sent partly through a layer of water and partly through a five per cent solution of ferro-ammonium sulphate in a glass chamber, being at the same time concentrated by a system of lenses into a small spot.

I also obtained the inner infra-red rays from the carbon arc lamp by quite a similar process, the filtering off here being performed only through a solution of iodin in bisulphid of carbon instead of water and ammonium sulphate.

The experiments were carried out in such a manner that the inner side of the lower arm of various people was used as a subject of radiation. Here a spot of three cm. in diameter is always irradiated through a hole in a screen. By means of an adjusting mechanism the quantity of the radiant heat can be varied until the arm just receives the quantity it can bear without being burned. When this point has been reached the arm is removed and in its place is fitted a blackened thermocell for measuring the number of calories which were radiated per unit of surface and of time.

As you see on table No. 1, I have with a series of different persons found that with only small individual variations, they can bear much more heat calories radiated on to the skin with luminous rays then with inner and outer infra-red rays. This may be seen by the average figure 3.11 calories by luminous rays as against 1.33 calories by outer infra-red rays and 1.79 calories by inner infra-red; thus more than twice as much luminous heat can be borne as ordinary invisible heat radiation.

This observation is, however, not sufficient to decide with reliability whether the luminous rays, as heat rays, should be of any specific interest for the organism. The deciding question is naturally not whether the irradiated quantity of heat differs, but whether the quantity of heat absorbed differs. It was possible that so many of the luminous rays were reflected by the surface of the skin and not so many of the invisible ones that the quantities which were absorbed were in reality somewhat equal. To clear this question, I was forced to study the reflection of the skin for the three kinds of rays.

As far as I was aware there existed no similar investigations in this direction. I examined the reflection of the luminous rays by the skin partly directly and partly indirectly. Directly I examined it by comparing the reflection of white filtering paper, which it is known, reflects 80 per cent of the rays. If two weak light emitters are arranged far from each other in a dark room, and on the line connecting the two lamps we find the point where turned towards the one lamp the skin on the inner side of the lower arm, and turned towards the other lamp a piece of white filtering paper appear to be equally well lighted, i.e. reflects the same quantity of light, it will be possible to find how much the skin reflects when the reflection of

the paper, namely 80 per cent, is known. In this manner I have found by repeated tests the reflection of the skin of the lower arm at about 35 per cent.

The reflection of the invisible heat rays by the skin can, of course, not be examined in this manner. On the whole, I have not been able to find in literature anything on the measuring of the reflection of the infra-red rays by non-mirroring surfaces. Instead of finding the spread of invisible reflection directly, I have had to do this by indirect means, namely by finding the absorption. I took the thin, shaved skin of white mice and applied it by aid of a thin layer of fat sparingly mixed with blood to the silver plate of a thermocell so that the surface resembled as far as possible the natural surface of the skin. The back of the silver plate of the thermocell was completely blackened with soot, which absorbs every radiated energy, whether visible or invisible, and does not reflect anything. If I now irradiate the blackened side and thereby ascertain how great the radiating energy is, and thereupon turn the cell and give the same irradiation on to the skin covered surface I can calculate from the difference of the two measurements how much of the radiated energy has been absorbed, thus also how much the skin has reflected. I made several such experiments and have found—with small deviations—the following as an average:

The surface of the skin does not reflect any of the outer infra-red rays; they are all absorbed.

Of the inner infra-red rays 35 per cent are reflected and of the visible ones also 35 per cent are reflected, being quite the same figures which I found by direct measuring. The quantity of the various kinds of rays which are absorbed, if we irradiate in this manner, appears from table No. 2.

The quantity of calories which can be absorbed by the skin during an irradiation with visible rays, without being burned is, as you see from the table, about twice as great as that which we can absorb by irradiation with invisible heat rays.

After it had been found that twice as much heat by radiation with visible rays can be absorbed as by radiation with invisible rays, the next question was: what temperature do the two kinds of rays produce on the surface of the skin and in the underlying parts when the irradiation is so strong that it can be borne without burning? I then measured the temperature on the skin during the strongest possible irradiation with the two kinds of rays, and also about fifteen

TABLE NO. 1

		Visible Rays		Outer Infra-Red Rays		Inner Infra-Red Rays	
	Date	*Cal.*	*Room Temperature*	*Cal.*	*Room Temperature*	*Cal.*	*Room Temperature*
J. J.	1-10	2.93	24.0 degrees	1.31	24.0 degrees		
	1-12	3.10	23.0 degrees	1.43	23.0 degrees		
	1-13	3.29	22.5 degrees	1.26	22.5 degrees		
	1-14	2.33	23.5 degrees	1.22	23.8 degrees		
	1-17	3.42	23.0 degrees			1.96	23.7 degrees
	1-19			1.26	22.7 degrees	1.56	21.5 degrees
K. H.	1-10	2.21	24.2 degrees	1.09	24.3 degrees		
	1-13	3.20	24.0 degrees	1.23	22.8 degrees		
	1-17	2.89	23.8 degrees			1.79	23.5 degrees
N. H.	1-10			1.33	24.5 degrees		
A. T.	1-12	3.90	23.0 degrees	1.71	23.0 degrees		
M. E.	1-13	3.75	23.0 degrees	1.40	22.6 degrees		
K. S.	1-13	2.62	23.8 degrees	1.32	23.9 degrees		
C. S.	1-10	3.04	24.0 degrees				
	1-12	2.93	22.8 degrees	1.53	22.7 degrees		
	1-17	3.95	24.0 degrees			1.86	24.0 degrees
	1-19			1.23	23.7 degrees	1.76	22.0 degrees
	On an Average	3.11		1.33		1.79	

seconds after the irradiation. For the latter it is comparatively simple to obtain an approximate measure. It is done by simply suddenly switching off the irradiation of the spot, and then placing a thermocell, a little silver plate, on the spot and reading after fifteen seconds have passed.

I then get, as table No. 3 shows, as average of a series of measurings on various individuals, 40.8 degrees for visible rays and 39.7 degrees for invisible rays; thus one degree more in the former case than in the latter a short time after the irradiation had been discontinued. It is considerably more difficult to measure the temperature of the skin during the irradiation. Of course, the thermocell may not be irradiated itself, and as soon as it is placed on the skin, there is no more irradiation on that spot. I therefore proceeded in such a manner that by aid of an electric resistance wire, wound around the thermocell, I first heated the cell to a temperature assumed to be lying close to the temperature of the skin to be measured. If this thermocell is, at the same moment when the irradiation is screened off, placed on to the skin, the galvanometer index of the thermocell will perform a sudden movement up or down, according to whether the temperature of the thermocell has been higher or lower than that of the skin irradiated. By gradually reducing the temperature limits, within which the temperature of the skin lies, I have been able to ascertain with great accuracy the temperature of the skin during irradiation as may be seen on table No. 4. As you see, the irradiation temperature lies very much at the same figure with various people for the same irradiation. The temperature of the skin is on the average at the strongest irradiation with visible rays bearing 43.8 degrees, and at the strongest irradiation with invisible rays bearable 45.5 degrees. In the latter instance, therefore, it is about two degrees higher than in the former. It was about the reverse with the temperatures fifteen seconds after irradiation had been discontinued. There was one degree more after the irradiation with visible rays. What does that now show us?

TABLE NO. 3.

	Visible Rays		Outer Infra-Red Rays	
	Skin Temperat.	*Room Temperat.*	*Skin Temperat.*	*Room Temperat.*
J. H.	41.9	....	39.8	.....
	39.1	21.5	38.3	22.0
	39.9	22.0	.....	.....
	40.6)	22.2	38.5	22.2
	40.1)			
	40.6	22.5	29.2	22.5
Average	40.4		39.0	
J. J.	41.0	.....	38.4	.....
	38.0	21.5	39.2	21.5
	41.0)	22.4	41.3)	22.4
	41.0)		41.3)	
	40.7	22.7	40.2	22.8
Average	40.3		40.4	
M. E.	41.3)	19.8	40.4	19.8
	41.8)			
Average	41.6		40.4	
E. F.	40.4)	20.8	30.0	20.8
	40.0)			
Average	40.2		39.0	
F. L.	40.8)	21.5	39.3	21.5
	40.5)			
Average	40.7		39.3	
F. B.	39.7)	22.3	39.0	22.3
	39.3)			
Average	39.5		39.0	
M. P.	42.2)	22.4	40.8	22.4
	42.0)			
Average	42.1		40.8	
M. J.	41.1)	23.0	39.3	23.0
	40.0)			
Average	40.6		39.3	
Ave. for all	40.8		39.7	

We can absorb twice as much irradiation by visible rays as by invisible rays, but nevertheless the temperature of the surface of the skin is considerably higher with the latter irradiation than with the former. This can only mean that the invisible heat rays are absorbed immediately on the surface of the skin and have very quickly heated the same to a temperature which is so high that we hardly can bear it, and therefore, a further irradiation is prevented. The visible heat rays, on the contrary, pass to an essential degree through the surface; they do not heat the same so violently, and a far greater heat irradiation can therefore be borne in this manner. But the tissue beneath the skin is, on the other hand, much more heated by the visible rays. This is seen by the fact that the tempera-

TABLE NO. 2

Of visible rays	3.11	0.65=2.02	Cal. per cm.^{2} per minute
Of inner infra-red rays	1.79	0.65=1.16	Cal. per cm.^{2} per minute
Of outer infra-red rays	1.33	1=1.33	Cal. per cm.^{2} per minute

ture of the skin, after the discontinuation of the irradiation, is higher with irradiation by visible rays than with irradiation by invisible rays. In the former case the heat from the deep layers is transmitted to the surface of the skin while in the latter case the heat is quickly transferred from the surface of the skin to the surrounding air after the irradiation.

More heat penetrates the subcutaneous tissue during an irradiation with visible rays than during an irradiation with invisible rays. The problem now is: what effect does this have on the subcutaneous tissue and how does it happen that the heat is absorbed? The upper layer of the skin consists of comparatively clear sclerous cells, through which the luminous rays pass rather unweakened. They are not absorbed until they meet the blood carrying layers at greater depths, which owing to the red color of the blood, absorb the light. It is here in the blood that the heating of irradiation with visible rays must take place. The strongly luminescent white rays of light show their greatest energy in the yellow portion of the spectrum between the Frauenhofer lines E and D which in particular are absorbed by the blood.

Right until the visible rays reach the blood carrying stratum in and beneath the skin, the temperature will rise from the surface of the skin and towards the inside during the irradiation. Only after the essential absorption has taken place will there again be a drop. Contrary it is with an irradiation with invisible rays. Here the maximum temperature is right at the surface of the skin and drops thereupon evenly with the depth. I have made several calculations of these conditions of the temperature and have come to this diagram which indicates how the temperature in and beneath the skin must be during the two kinds of irradiations.

S indicates the surface of the skin. If it is irradiated as strongly as can be borne with infrared rays, we have a temperature of about 45.5 degrees on it from which the temperature curve will drop evenly with the depth until at one cm. depth it reaches the normal temperature of 37 degrees. By irradiating with visible heat rays as strongly as possible we have a skin temperature of only 43.8 degrees, but the temperature rises with the depth and will, at a depth of about .5 cm. reach up to about 48 degrees, and from there it will drop to the normal. It is the blood carrying stratum in and beneath the skin which, by irradiation with luminous rays attains this high temperature (47.7 degrees). In a corres-

TABLE NO. 4.

	Visible Rays		Outer Infra-Red Rays	
	Skin Temperat.	*Room Temperat.*	*Skin Temperat.*	*Room Temperat.*
T. H.	43.8	22.0	44.9	22.0
	greater than 43.6 less than 44.0		greater than 44.7 less than 45.1	
	42.6	22.5	45.2	22.3
	greater than 42.2 less than 43.0		greater than 44.8 less than 45.6	
	43.7	22.5	44.3	22.5
	greater than 43.6 less than 43.8		greater than 44.1 less than 44.4	
Average	43.4		44.8	
J. I.	43.0	22.0	44.9	22.0
	greater than 42.8 less than 43.2		greater than 44.8 less than 45.0	
	44.2	22.5	44.8	22.5
	greater than 43.9 less than 44.4		greater than 44.4 less than 45.1	
	44.0	22.7	44.6	22.8
	greater than 43.8 less than 44.2		greater than 44.5 less than 44.6	
Average	43.7		44.8	
F. L.	43.9	22.0	44.6	22.0
	greater than 43.8 less than 44.0		greater than 44.3 less than 44.9	
F. B.	43.4	22.9	45.7	22.8
	greater than 43.2 less than 43.6		greater than 45.4 less than 45.9	
M. P.	44.8	22.5	47.6	22.9
	greater than 44.7 less than 44.9		greater than 47.4 less than 47.8	
M. J.	46.2*	22.9	46.0	22.3
	greater than 46.0 less than 46.4		greater than 45.7 less than 46.3	
*Average for all except M. J.	43.8		45.5	

TABLE NO. 5.

	Visible Rays			Outer Infra-Red Rays			Inner Infra-Red Rays		
	Surface Temp.	*Depth Temp.*	*Rise of Temp. in the Depth*	*Surface Temp.*	*Depth Temp.*	*Rise of Temp. in the Depth.*	*Surface Temp.*	*Depth Temp.*	*Rise of Temp. in the Depth.*
J. J.	42.8	45.0	+2.2	43.8	42.2	—1.6	.....	.....	.....
	39.7	41.4	+1.7	42.9	40.4	—2.5	43.0	40.3	—2.7
T. H.	39.9	41.8	+1.9	42.8	40.3	—2.5	.....	.....	.....
	42.7	43.5	+0.8	42.8	40.2	—2.6	43.7	43.3	—0.4
C. S.	39.8	44.3	+4.5	43.1	41.6	—1.5	44.4	41.6	—2.8
M. E.	43.3	43.2	—0.1	45.8	38.4	—7.4	46.0	42.3	—3.7
E. O.	42.2	42.3	+0.1	44.9	40.7	—4.2	44.4	41.1	—3.3
Average	41.5	43.1	+ 1.6	43.7	40.5	—3.2	44.3	41.7	—2.6

ponding depth we have, by irradiating with invisible heat rays a temperature of barely 42 degrees. By irradiation we have thus been able to heat the blood beneath the irradiated spot to about 48 degrees, or to five degrees higher than we can heat it with ordinary heat rays. You again see here of what enormous difference it is whether the organism is irradiated with luminous heat rays or with invisible heat rays.

The figures for temperatures at a depth, which I have mentioned, I have gained as said before, by caluculation. I have tried to measure the temperature in depth during the irradiation directly together with the temperature at the surface. Of course I have done this by inserting thermo-needles beneath the skin at the spot irradiated. Such a thermo-needle—an ordinary steel canula with soldering and wires—will by itself divert a part of the heat from the spot, the temperature of which it is desired to measure. Therefore it cannot be expected that the temperature which is measured is the same as that at the spot when the needle is not there. Besides it will be a little accidental at what depth the soldering will be. Owing to these circumstances the temperatures measured in the depth by means of the needle will not correspond to the figures found by calculation, but will be somewhat lower. Such a series of measurings, of which I have performed several, you see by table No. 5.

In spite of the unavoidable defects mentioned, which adhere to these measurings, you see nevertheless a very fine accordance with my calculations, namely that the temperatures measured lie about two degrees higher beneath the skin than at the skin surface when irradiated with visible rays, while when irradiated with invisible rays they lie about three degrees lower beneath the skin than at the skin.

The next problem is, accordingly: what importance for the organism have these peculiar conditions of the temperature with irradiation with luminous rays?

TABLE NO. 6.

	Visible Rays				Outer Infra-Red Rays			
	Body Temperature			Skin Temperature	Body Temperature			Skin Temperature
	Prior to Radiation	*After Radiation*	*Rise*	*After Radiation*	*Prior to Radiation*	*After Radiation*	*Rise*	*After Radiation*
Guinea Pig No. 1	37.8	40.2	+2.4	44.3	37.2	37.4	+0.2	43.0
	37.0	40.2	+3.2	42.9	37.2	38.2	+1.0	44.6
	37.5	39.2	+1.7	44.9	38.0	37.9	—0.1	46.6
Average	37.4	39.9	+2.5	44.0	37.5	37.8	+0.3	44.7
Guinea Pig No. 2	38.5	40.6	+2.1	44.4	38.5	38.5	+0.0	45.1
	38.3	40.4	+2.1	42.6	38.6	39.0	+0.4	45.6
Average	38.4	40.5	+2.1	43.5	38.6	38.8	+0.2	45.4
Guinea Pig No. 3	37.8	41.4	+3.6	43.4	38.2	38.3	+0.1	44.7
	37.5	39.3	+1.8	42.0	37.8	38.0	+0.2	44.9
	37.4	38.3	+0.9	43.2	38.0	37.9	—0.1	44.8
Average	37.6	39.7	+2.1	42.9	38.0	38.1	+0.1	44.8
Guinea Pig No. 4	37.8	41.2	+3.4	43.8	38.2	39.0	+0.8	46.1
	38.0	40.3	+2.3	42.0	38.0	38.5	+0.5	46.2
	38.4	40.5	+2.1	44.4	38.5	38.4	—0.1	46.4
Average	38.4	39.6	+1.2	43.9	38.0	38.6	+0.6	46.4

TABLE NO. 7.

Light Animals			Control Animals		
		Died After			*Died After*
No.	*Weight, Grams*	*Days*	*No.*	*Weight, Grams*	*Days*
1	290	living	1	255	living
2	270	living	2	275	5½
3	270	living	3	325	4½
4	295	living	4	265	4½
5	230	living	5	270	4½
6	350	10	6	290	3½
7	410	9	7	275	3½
8	290	7½	8	230	3½
9	280	7½	9	255	3½
10	280	6½	10	330	2½
11	270	5	11	255	2½
12	270	4½	12	235	2½
13	255	4	13	355	2½

For the first, one may ask what does the organism do with the large quantity of heat which it is able to absorb at an irradiation with luminous heat rays? It is evident that if the organism shall be able to bear a light bath with such rays, for some reasonable time, it must also be able to eliminate this heat as quickly as possible. Otherwise there would be observed a steady increase of the body temperature, which of course is impossible to bear. The human organism has normally a very fine heat regulation. But for example, a strong sun bath can only be borne if the irradiated part of the body is naked and a strong transmission of heat can take place therefrom directly and by perspiration. The non-pigmented body can only bear a sun bath of short duration without receiving a universal rise of temperature. The pigmentation, which gradually arises, prevents too many luminous heat rays penetrating into the depth and allows the sun bath gradually to last much longer without any discomfort. Probably a great part of the value of the pigmentation lies in this. If there arises no pigmentation, it is also impossible to attain sun baths of long duration, which are supposed to be necessary for attaining a good effect. That light baths really have thus a tendency of raising the body temperature contrary to an irradiation with invisible heat rays, I have very nicely been able to demonstrate on guinea pigs which have not so fine a heat regulation as man. I shaved a number of white guinea pigs on their backs and irradiated them as strongly as I could without burning the skin, partly with luminous and partly with invisible heat rays. After a certain irradiation I measured partly the rectal temperature, partly the skin temperature at the irradiated part and thereby obtained the figures which appear from diagram No. 6. As you see, there is in all experiments with visible rays a considerable rise in the body temperature up to three degrees or more, while in an irradiation with invisible heat rays we have only a very immaterial rise, if any. Nevertheless the skin temperature, quite in accordance with my former experiments, is considerably higher at irradiation with invisible rays than with irradiation with visible rays. I have shown the results of this experiment in table No. 4. It is apparent, therefore, that guinea pigs, the skin temperature of which was about two degrees lower when exposed to visible rays than when exposed to invisible heat rays, may nevertheless experience a rise of the body temperature that is two degrees higher.

Experiments which quite confirm this observation have later on been made by others—Leonard Hill in London, and Dorno and Loewy in Switzerland.

The next question is: could it be of any therapeutic importance for the human organism to have the blood in the blood-carrying strata in and beneath the skin irradiated, heated to a very high temperature, up to 45 degrees or perhaps more by even two or three degrees? Here I must ask you to pay careful attention to the peculiarity heretofore mentioned of the light bath on the well heat regulating human organism in man, one can by means of the light bath heat a considerable part of the blood volume to a temperature which lies much above the highest fever temperature, without the universal body

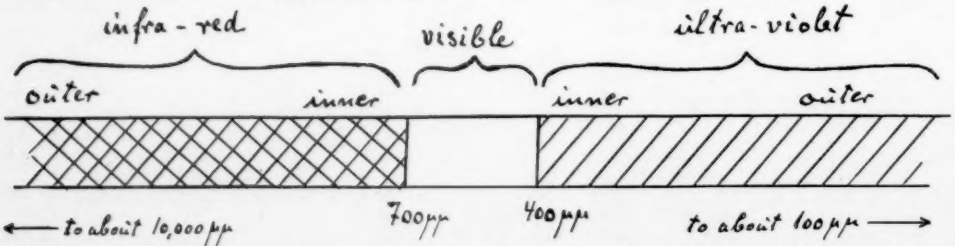

Fig. 1. Heat spectrum showing relationship of infra- red and ultraviolet rays to the visible rays.

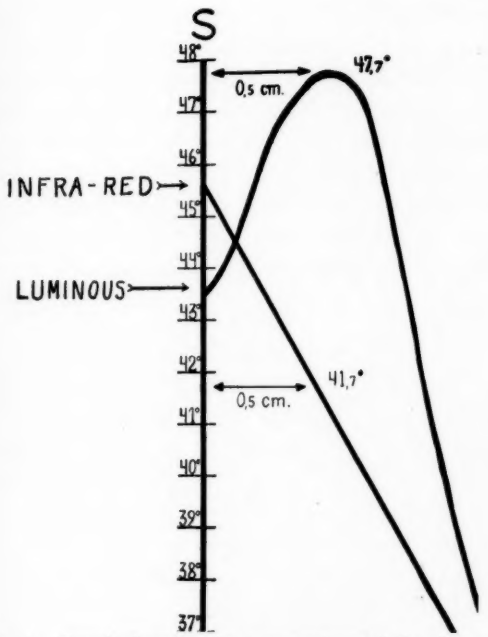

Fig. 2. Graph showing the temperature of the skin and subcutaneous tissues when irradiated with luminous and infra-red rays.

temperature rising above the normal. This is what can be obtained by a light bath with luminous rays, and it is evidently here that the point must be sought if we are seeking the possible therapeutic advantage of the luminous heat rays in the light bath.

Such a specific effect on the organism can hardly be attained by any other known procedure. Invisible heat rays, including a light bath with incandeecent lamps, sollu, etc., of which only about 4 to 5 per cent of the radiant energy is light, can not give a similar effect, and treatment with conduction of heat (warm water baths, mud baths, Turkish baths, etc.), will either not heat the blood more than normally, if the organism regulates sufficiently well, or the blood temperature will show a rise, but only because the body temperature increases. Only by diathermy an effect may possibly be attained which to some degree corresponds to that of the light bath, but as in diathermy only a small, limited part of the whole organism is heated, the effect of this on the blood will never be able to have the same importance as the light bath in this respect.

Time is lacking to give an exhaustive survey of all the investigations made in the course of time concerning this subject, so I shall restrict myself to mention that a series of authors have succeeded in establishing that subject animals, the body temperature of which is induced to rise, show a greater tolerance towards various infections than under normal conditions. Moreover, it has been demonstrated from several sources that heating may have an action upon the formation of anti-bodies.

M. Lissauer thus showed that rabbits which have previously been infected intravenously with sheep corpuscles and the serum of which has acquired hemolytic qualities towards these, will show a considerable increase of this hemolytic capacity by convection of heat (some minutes immersion in hot water). Quite the opposite results were obtained by cooling the animals. Ludke, studying typhoid agglutination before and after heating, arrived at identical results; the same also is true of Fukuhara.

According to Laache's view—with which one would be inclined to agree—the catalogue of sins of fever (elevation of temperature) is, however, long and rather grave. Its effects are deleterious and destructive to the organism to say nothing of its directly endangering life when exceeding a certain level.

After what I have hitherto set forth, there seems to be accordingly some reason to believe that in the light bath with visible heat rays, we have a therapeutic agent which possesses all favorable effects which a real or artificial in-

Fig. 3. Graph showing effect of irradiation with luminous rays on patients injected with typhoid vaccine.

crease of the body temperature may have on the organism, but none of the detrimental ones.

We have made a number of experiments to confirm, if possible, this opinion on the therapeutic value of the luminous rays. In my laboratory Dr. Hansen examined the effect of the light bath on the typhoid agglutinan diagrams with human patients after a single injection of typhoid vaccine, thus dead typhoid bacilli. As it is well known such a diagram rises steeply to a point and then drops almost just as steeply and evenly, about as you see on this diagram where the apex, however, is not shown. A number of persons have been examined who, after injection of the killed bacilli, have for a lengthy period received a carbon arc light bath every other day. On the whole 23 persons were examined. With a part of them the light bath had no influence on the form of the diagram and this diagram is from such an instance. The arrows indicate the light baths. But in more than half the cases the diagrams are clearly changed, as, for example you see in Fig. No. 3 where the diagram descends slowly, unevenly and in terraces, or in Fig. No. 4 where after the light baths there is an extra rise, and later on a large terrace instead of a drop. Also in Fig. No. 5 there is an extra rise. There can hardly be any doubt whether at these experiments the heating of the blood under the surface of the skin irradiated has contributed to an increased formation of agglutinin in the organism, or contributed to keeping up this anti-substance for a longer time on a much higher level than it otherwise would have reached.

I have also made experiments to show the directly heat destroying effect on thermolabil toxins in the blood, which the luminous heat rays could be imagined to have. Diphtheria toxin is such a thermolabil toxin. We know from Famuleuer and Madsen's experiments that each time a toxin is heated to a temperature by five degrees higher, 78 times as much is destroyed as at the lower temperature. When there is a question of thermolabil toxins this will play, of course, an important part in the organism. At the maximum fever temperature, namely 42 degrees, 78 times as much is destroyed as at the body temperature. But if we go up to 47 degrees which is the temperature the blood may reach under luminous heat rays, $78 \times 78 =$ about 6,000 times as much toxin is destroyed as at 37 degrees. It is of course only a small portion of the blood which has at one time the temperature which causes such an effect, and this only for a short time. But the figure, 6,000 times, is so high that nevertheless there is a high probability that these circumstances may be of a very great importance.

I have made experiments with shaved white guinea pigs into which I have injected a unitinal lethal dose of diphtheria toxin. Immediately after, I placed them for two hours into a light bath with luminous rays. Of course, at this experiment, care was taken that the light was not stronger so that any increase of the body temperature would not result this time. After the light bath the animals were taken back to their cage where they were together with the simultaneously injected controlling animals. The result of this experiment is shown here in table No. 7. There were 13 irradiated and 13 controlling animals. The later died after about four days as was supposed, corresponding to the doses of toxin injecten. Only one remained alive as it happened, but of the irradiated animals, five lived and the remainder lived considerably longer than the controlling animals. By aid of Arrhenius' and Madsen's table on the relation between the dose of diphtheria toxin and the duration of life after the injection of the toxin I have calculated that about 40 per cent of the toxin dose injected had been destroyed by the one light bath. As it was important for me to show that such a toxin destruction could occur without any increase of the body temperature, I have, as said, in these experiments not made the irradiation stronger that such a universal heating could be avoided. As man regulates better than a guinea pig, a corresponding light bath would have been much stronger and the toxin destruction probably still greater.

So as to avoid misunderstandings, I would say that febril conditions—for instance as diphtheria in people—where often too much toxin may be assumed in the organism, are hardly suited for light treatment. When the body temperature is increased in advance a light bath

would probably raise it still further, which will often cause too great a risk.

There exist hardly sufficient opinions that with chronic infectious diseases without fever, for example many forms of surgical tuberculosis, there is thermolabil toxin freely circulating in the blood. But the possibility of this is not out of question. If this is the case a part of the excellent effect of the light bath on these diseases may very well be owing to the luminous heat co-operating in the destruction of this toxin. That all the anti-substances which may be in the blood with this and other diseases may also be influenced to an advantage by heating of the blood during the light bath, must also be reckoned with as a factor of very considerable importance.

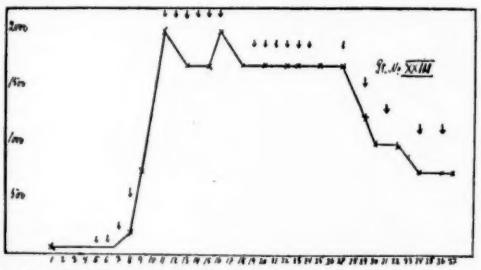

Fig. 4. Another patient's curve.

The study of the importance of the ultraviolet rays in the treatment of many diseases has, as you all know, particularly in the latter years, been made with great energy all over the world. I shall here avail myself of the occasion to most urgently draw attention to the fact that during a strong ultraviolet light bath, strongly light emitting sources of light are used, and a therapeutic effect is observed, it is not possible, as long as there are no positive proofs, to know whether the effect obtained is based on the ultraviolet rays or on the luminous rays. As I have shown, the irradiation with luminous rays has a quite specific effect on the animal organism, and there are facts which speak much for this effect being of great therapeutic importance.

DISCUSSION

DR. VICTOR LEVINE (Omaha, Nebr.): The question of physical therapy with relation to light is just beginning in its scientific career, and we are very grateful to men like Professor Dr. Carl Sonne who have made it a life work and have seen fit to contribute to the fundamentals of so important a science.

We are using physical therapy at present with more or less effect, and we are not yet prepared to know the why and the wherefore. The why and the wherefore are not important merely from the standpoint of theoretical satisfaction, but are much more important from the standpoint of greater therapeutic efficiency. It is such contributions as the one we have heard tonight that make for this greater therapeutic efficiency. If we could understand the physiology of the various types of wave lengths, if we could understand their possibilities and their limitations, then we might use them to greater advantage. There are so many things in ordinary sunlight and there are so many types of rays in our various carbon arc lamps, and other lamps on the market, that we are apt to attribute the results to one tree, instead of to a number of trees or to the forest.

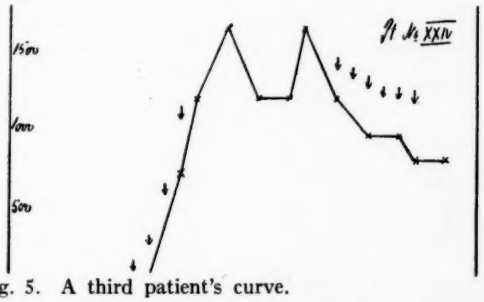

Fig. 5. A third patient's curve.

Since in the last few years the idea has been developed that ultraviolet may also have deleterious effects, it is all the more important that we should study the various types of side wave lengths that go with the pure ultraviolet.

One of the most important causes of death, no doubt, is still infection; in spite of the rise in the so-called wear and tear diseases, the degenerate diseases, we still suffer, no doubt, from the respiratory diseases such as diphtheria, pneumonia, and the like, and there is no doubt that the question of heat as a therapeutic method is a response for the purpose of protecting and warding off danger from toxin of any type.

It is a well known fact that heat applied locally, that the elevation of heat internally, is a great factor in stimulating the endocrine glands, in developing antitoxin. At the same time, it is also a great factor in stimulating the destruction of toxin, and whatever method we can develop or any method we can invent or discover that will affect the heat regulation in such a way as to destroy the toxin much more efficiently than we know how, is surely a method that should be taken on with great enthusiasm, for it means the quick and rapid destruction of an enemy that is liable to overwhelm us.

I believe that the report of Dr. Carl Sonne is a tremendous, an epoch making report, in so far as the possible theoretical relation and the practical relation which Dr. Sonne has been kind enough to show to us in relation to the effect of the light rays on the very much annoying antitoxin of diphtheria.

I, for one, congratulate Dr. Sonne, because he has stimulated thinking of the wonderful possibilities yet to be unearthed in the new field of physical therapy.

ZINC IONIZATION CONSIDERED FROM THE ELECTRICAL AND BACTERIOLOGICAL STANDPOINT*

DR. A. R. FRIEL
LONDON

What part does the electric current play in this method of treatment?

The diagram (Fig. 1) will make this plain. On the left is a glass containing a solution of salicylate of sodium, and above a hand is pouring a solution of perchlorid of iron into the glass. A glass rod is mixing the two solutions. A deep purple color becomes visible. In the glass on the table the sodium salicylate dissolved in water has dissociated into the ions of sodium and salicyl. In the glass in the hand the perchlorid of iron dissolved in water has dissociated into the ferric and chlorin ions. The chemical reaction which takes place when the solutions are mixed is a reaction between ions, and the agent which did the mixing was *mechanical.*

In the second diagram (Fig. 2) there are two vessels containing salicylate of sodium, and one containing perchlorid of iron. The vessels are connected by inverted U tubes containing tap water. A constant current is allowed to flow through the system and after a short time a deep purple color is formed by the chemical reaction between the salicyl ions traveling towards the positive electrode and the ferric ions traveling towards the negative electrode. Here also the reaction is between ions, but the agent which brought the ions into contact is *electrical.*

The chemical reaction between ions is a reaction between bodies which have opposite electric charges and therefore attract each other, but such chemical reactions as the first slide shows, take place in the absence of the continuous electric current. The moving of the ions by the electric current is the factor which distinguishes the treatment called ionization from treatment which consists in placing lotions on the surface of a wound.

*Read by special invitation at the seventh annual meeting, American College of Physical Therapy, Oct., 9, 1928.

Most of the illustrations from author's book, "Notes on Chronic Otorrhea", by courtesy of Messrs. Wright and Son, Publishers, Bristol, Eng.

Zinc ions introduced into a solution of albumen coagulate the albumen. This occurs whether the zinc ions are added to the albumen by pouring into the vessel containing the albumen some sulphate of zinc solution, or by making the zinc ions penetrate the albumen by the help of the continuous electric current.

Let me show you diagrams of three experiments in regard to this:

The first (Fig. 3) is of an experiment devised by Professor Leduc.

Blood serum is poured into a glass vessel and four wires dipped into the serum. One of these wires, which may be of any metal, is connected to the negative terminal of a battery. Each of the three remaining wires is connected in turn to the positive terminal. One of the wires is of iron, another of copper and the third of zinc. When the current flows it will be seen that around the iron wire there is little visible change. The serum in immediate proximity becomes denser and sinks to the bottom. Around the copper wire a flocculent precipitate is formed and if the vessel is shaken or tapped the clot can be detached. Around the zinc wire a firm white clot is formed and if the wire is lifted up out of the solution the clot adheres to it. When zinc ions are introduced into wounds by the electric current the firmness of the coagulation prevents the coagulum being dissipated quickly.

Experiment 2

Blood serum, or a solution of white of egg, is mixed with gelatin and poured into a U-tube (Fig. 4) and allowed to set. The tube is then inverted and one limb is dipped into a solution of zinc sulphate and the other into one of common salt. A zinc wire is dipped into the zinc sulphate solution and connected with the positive terminal of a battery. A wire attached to the negative terminal dips into the solution of chlorid of sodium.

When the current has flowed for some time it will be seen that a white coloration appears at

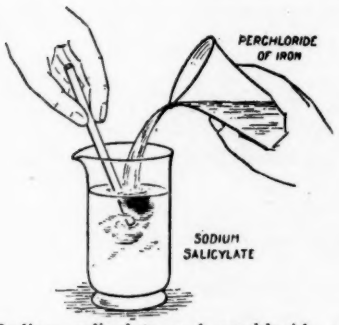

Fig. 1.—Sodium salicylate and perchloride of iron.

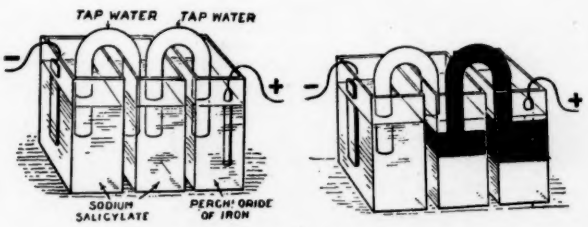

Fig. 2.—Two vessels, one of sodium salicylate and perchloride of iron.

the end of the tube dipping into the zinc and gradually mounts as the time during which the current flows, passes. This white coloration is the precipitate formed by the union of zinc ions with the albumen of the blood serum or of the white of egg. It will be noticed that the delimitation between the coagulated and the uncoagulated portion is sharp.

Diagram 5 shows how easy it is to watch the same process taking place under the microscope. Serum or white of egg mixed with a little gelatin is placed on a glass slide and a cover glass applied. Some gelatin containing a zinc salt is poured on the glass at one side of the cover slip and touches the serum or white of egg, while gelatin containing salt is poured on the glass slide on the opposite side of the preparation.

The electric circuit is completed by lint laid on the bare patches of gelatin and dipping into vessels, one of which contains zinc sulphate solution and the other common salt solution. When the current flows, it is instructive to watch the steady advance of coagulation in the serum under the cover glass from the positive side. The coagulated sheet will be seen to be finely granular.

Experiment 3

A U-tube (Fig. 6) is filled with nutrient gelatin or nutrient agar to which has been added blood serum and glucose, and has been heavily implanted with B. Coli.

Zinc ions are made to penetrate as in Experiment 2, and when the coagulation has extended half way along the tube the current is turned off and the tube removed from the vessels and placed in the incubator. When examined next day, it will be seen that the portion into which the zinc ions have been introduced is as it was, while the medium in the remaining portion of the tube is broken up by bubbles of gas formed from the fermentation of the glucose by the B. Coli. If the portion of the tube into which the zinc ions have penetrated be cut into

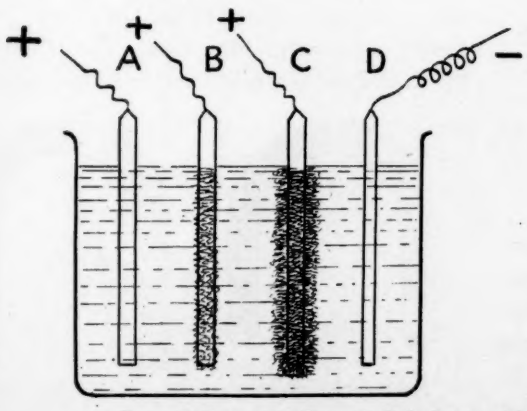

Fig. 3.—A, iron; B, copper; C, zinc; D, rod of any metal.

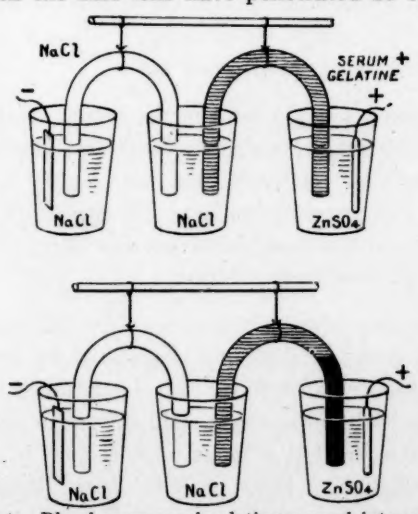

Fig. 4.—Blood serum and gelatine poured into vessel.

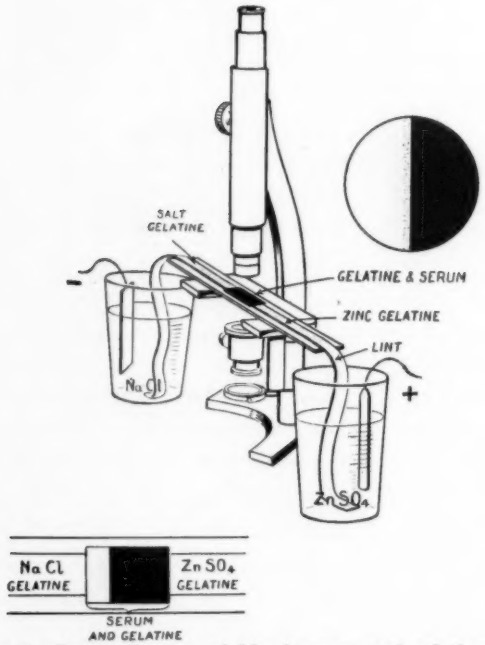

Fig. 5.—Large diagram of blood serum and gelatine.

sections and cultures made, it will be noted that some growth, especially from the part farthest from the end of the tube, will be obtained.

The experiment shows that zinc ions inhibit the activities of the bacteria. The zinc ions are antiseptic in their action. Three things should be especially noted:

1. The permeation. If the material is homogeneous the permeation is even.

2. The penetration. The stronger the current and the longer it flows the greater the depth to which the zinc penetrates.

3. The sharp delimitation between the coagulated and uncoagulated part.

By means of the heat of the actual cautery we can coagulate exudation, and also destroy the tissues of the body, but we cannot limit sharply the action of the heat. It shades off so that around the coagulated portion there is a zone of inflammatory reaction.

Attention should be drawn to the difference between tissue in the body coagulated by heat, and tissue coagulated by the introduction of zinc ions. The former is a good culture medium for bacteria, while the latter inhibits growth. In fact, exudation, a layer of cells on the surface of a wound, or mucous membrane, permeated with zinc ions protects subjacent cells from irritation.

Clinical experience furnishes numerous examples of the benefit resulting in cases of suppuration from treatment by zinc ionization.

The above examples explain the mechanism whereby this benefit is obtained.

Let us now consider the conditions in the body which are amenable to treatment by zinc ionization. These conditions come almost entirely under the head of local septic conditions.

In a patient we may have: (1) Sepsis *in* the tissues and (2) Sepsis *on* the tissues.

A. Sepsis in the tissues may be (a) *diffuse and spreading,* such as erysipelas and gas gangrene; (b) or *localized,* such as in carbuncle, abscess, boil.

B. Sepsis on the tissues is seen in carbuncle, abscess, boil and sinuses, when necrosis has occurred and pus is present, as well as in such conditions as purulent inflammation in cavities lined by mucous membrane, e. g., the middle ear, the nasal accessory sinuses, and the cavity of the uterus.

It is not possible to treat diffuse and spreading septic inflammations such as erysipelas by zinc ionization. In our efforts to surround the germs with an antiseptic medium we should destroy the tissues.

In localized sepsis *in* the tissues such as occurs in the early stage of a carbuncle, it is good treatment, as advocated by Professor Leduc, to plunge one or more zinc needles into the inflamed carbuncle and infiltrate the inflamed tissues with zinc ions. The activities of the microbes are inhibited, but we sacrifice a

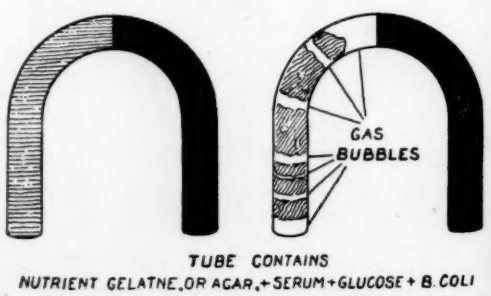

Fig. 6.—Nutrient gelatine, or agar+serum+glucose+B. Coli.

certain amount of tissue which is coagulated by the zinc ions. The spreading of the inflammation is, however, arrested and the patient is spared the risk of a diffusion of the germs into his system which may follow if we incise and curette the carbuncle.

The conditions which present themselves most frequently in practice are cases of sepsis *on* the tissues.

During the stage of acute inflammation germs are *in* the tissues. The body is able in most cases to localize the fight and to banish the germs from the tissues. In the exudation from the tissues which persists as the acute stage is subsiding the germs may live and in it saprophytic germs from outside may find a lodging.

The body is not nearly so effective in dealing with a condition which exists strictly speaking *outside* the tissues as it is in the former case. It is for this condition—*infected discharge in contact with the tissues and irritating them*—that zinc ionization is so useful.

It is possible by mechanical means such as syringing, to remove *macroscopic* amounts of discharge, but it is not possible by any known mechanical means to cleanse the surface of a wound, or mucous membrane, from the *microscopic* film of infected material adhering to it. For this latter purpose zinc ionization is effective. One efficient application of zinc ionization is sufficient to inhibit the activities of the bacteria, to abolish the irritation resulting from their activity, and to protect the tissues by forming an antiseptic barrier between them and the outside world.

If the area to be treated is covered with granulation tissue we need not be nervous about the danger of giving an overdose. There is no objection to coagulating a layer of granulation tissue. If, however, we are ionizing a mucous membrane we must be careful, and be guided by experience, as to what is a safe dose. An excessive dose would destroy the mucous membrane. This is an organ and cannot be replaced.

The technic of zinc ionization may be summed up as consisting in covering the whole area irritated by infected discharge with zinc sulphate solution, distributing the electric current to the whole surface in adequate amount, and having done so, take steps to provide against reinfection.

A great help in forming an opinion as to the success of our efforts is to make a slide from the surface of the area which was inflamed, stain it and examine it with the microscope. By making smears from different parts we can learn whether our technic was sound or whether a pocket escaped our attention. The subsidence of inflammatory signs is the most marked result which strikes us on seeing a case the day after it has been treated by zinc ionization. We abolish reservoirs of infected material and remove irritation and our patient improves. If sepsis alone—not foreign bodies, caries, etc. is the cause of his trouble, he recovers rapidly.

RETICULO-ENDOTHELIAL SYSTEM AND DIATHERMY*

GUSTAV KOLISCHER, M. D.

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Biologists have recently discovered that there exists a complex of well defined cells within the body in which reside important defensive forces of the organism; this cell complex is called the reticulo-endothelial system.

In order to justify the term "system," it was necessary to demonstrate that the pertaining cells are of similar origin, morphology and physiologic qualifications. As a matter of fact they all are derived from the medium layer of the embryonic structure; they are large mononuclear cells and their physiologic qualities are very well defined. While these cells originally are established in certain organs, they are apt under stimulation to become mobilized and to travel to all parts of the body. They are attracted to any area in which an increase of metabolism occurs, for instance, excited by localized heating or by hyperemia. They are also able to penetrate the walls of the blood-vessels, and thus enter the general circulation. Another important faculty of these cells is represented by the fact that anywhere in the body they may be produced by metaplasia out of cells pertaining to the adventitia of the capillaries.

Summing up, one may say that these cells may be mobilized to appear in any area where their defensive action is needed. This defensive activity is mainly based on their faculty to embody, store and neutralize toxines irrespective of their provenience—whether they are the products of bacterial invasion or originate in metabolic processes indigenous to the human body. This faculty may be raised by the ability to take up within their cell-body certain proteins.

The cells of this reticulo-endothelial system are also intimately connected with all processes of immunization.

Diagnostically these cells may be recognized by their pronounced affinity to electronegative stains. Their capacity to embody these stains is proportionate with their functional activity. This fact is utilized to determine in the living their efficiency, or any decrease thereof in an indirect way. By injecting into the circulation a known quantity of such a stain, one is able to draw conclusions as to the functional capacity of these cells by observing the rate of speed with which the stain disappears out of the blood. A computation of these items with what we know of diathermy will very readily demonstrate the intimate connection between these issues.

Let us first consider medical diathermy. By placing structures under the influence of heat within physiologic limits we produce a localized hyperemia and stimulate the lymph flow. By virtue of this circumstance pathologic exudates are changed into a condition that facilitates their absorption. At the same time the macrophages pertaining to the reticulo-endothelial system are attracted to this area of increased metabolism, and a new formation of such cells will occur in the same location.

Two actions will simultaneously take place. While the cells of the reticulo- endotheliol system will absorb and destroy the toxine that causes the inflammatory infiltration, the increased circulation will facilitate the carrying off of the peptonized exudate. These conditions will also explain why prolonged diathermic sittings are so efficacious. It takes some time to attract, and reproduce defensive cells. From this view-point it also becomes understandable why production of excessive heat fails of its purpose, and may even be responsible for the aggravation of the morbid condition. Temperatures that do not yet produce coagulation but come pretty close to it, cause the precipitation of intracellular globulins. This interferes with the vitality of these defensive cells and prevents them from absorbing toxines. If under the influence of excessive heat the exudates are breaking down and no cells are available to neutralize the metabolic end-products, additional irritation with its sequelae will result in arthritis.

The increase in the therapeutic effect of the so-called asceptic protein shock if combined with

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medical diathermy is also readily explained. It is a matter of experience that practically all inflammatory processes based on bacterial invasion of the body are favorably influenced by the injection of aseptic proteins. The explanation lies in the raising by protein intake the absorbing power of the cells constituting the reticulo-endothelial system. Additional to that, the localized heating and hyperemia attracts these cells to the pathologic area and fosters their multiplication.

The superiority of the results of surgical diathermy, and the electrocoagulation of malignant tumors, is also based upon the collaboration of the reticulo-endothelial system. In the area around the coagulated structures, the so-called perithermic zone, there is always to be found an abundant invasion and neoformation of macrophages—easily demonstrable by intravital staining. These defensive cells not only attend to the particular destruction of the remaining cancer cells, but are also instrumental in leading to the production of regulating ferments, bringing the riotous multiplication and intrusion of malignant cells down to a normal level.

The clinical support of this conception rests on the following experiences. In numerous instances an incomplete coagulation of the malignant tumor is followed by complete recovery. In instances in which a true cure was not obtained each diathermic session is followed by a period of decided general improvement of the patient.

In cases in which a recurrence, after a certain period of time, called for a secondary electrocoagulation, the general reaction is of a decidedly lower grade than that following the first sitting, although the secondary coagulation may have been much more extensive than the primary one.

If I took the liberty of digressing into certain theories of biology I may be excused by the attempt of impressing on you the necessity for every specialistic man to keep in touch with the progress in other fields of medical science.

There is no addition to our theoretical knowledge that eventually does not become applicable to practical work, and which in the end does not improve our clinical results.

DISCUSSION

Dr. Gustavus M. Blech (Chicago, Illinois): I do not desire to enter into a strictly technical discussion, because Dr. Kolischer has covered the ground very thoroughly. But it is worth while to point out to you the extreme importance of really scientific endeavor. The question of how much influence the reticulo-endothelial system has in the defenses against all sorts of infections has been considered for some time. It was Professor Achsoff of Freiburg, the famous pathologist, who studied the system and applied the name of "reticulo-endothelial system" to it. It is he who is responsible for that term. Whether or not we concede that the whole problem is still in a theoretical stage or is already past that stage, is of small moment, for this much is sure, that it is leading up to an interesting study of the defensive forces of the body, which, in turn, overthrow our old time conceptions.

I emphasize two points which Dr. Kolischer brings out. You and I recall the time when we were a little bit younger and looked upon every inflammatory process following an injury or an infection as a terrible thing Get rid of that inflammation! We used to put on anything to bring it down.

Then came thinkers in our profession, notably Bier, who looked upon inflammation as a natural reaction to injury—as a defensive force. He, instead of suppressing inflammatory reactions, unless they were excessive so as to be harmful in themselves, tried to favor them. Hence hyperemia, hence heat, hence your diathermy.

If, as Dr. Kolischer hints, you wish in your physical therapy work to know the reasons why you do things, and not blindly make use of a machine. If you want physical therapy to be placed on the same scientific pedestal with what we call today pharmacologic therapy and surgical therapy, then you must know physiology, because scientific therapy must be based on physiology. Once we understand the biology of the human body, once we understand its biochemistry, we know what we need to know to become scientific instead of remaining merely empiric.

Dr. Kolischer's paper is very interesting and to the point. It may be all he said is still theory, requiring more experimental work to separate us from the old conception of infection, but that is not the issue. The main thing is that we secure a footing on solid ground and become scientific and not mere mechanical therapists.

NATURAL HELIOTHERAPY*

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Present day theory recognizes that every chemical reaction is started by radiant energy. The living animal absorbs stored up sun energy in the form of food, which, in itself or in its original form, the sun ray, excites the living organism to activity accompanied by setting free stored up energy. This latter is expressed in greater viability, body and mental activity and in other forms of increased viability of the living being. Whenever body energy is deficient, heliotherapy finds its indications. Bacteriæ, their toxins, lack of vitamins, calcium deficiency and other agents of enervation acting upon the human body may be regarded as the causes for general constitutional defects and secondary local manifestations. Solar radiation counteracts these agents, thus overcoming their ill effects.

The indications for solar radiation cannot be laid down by enumerating individual diseases. It should find application where, from theoretical consideration and from practical experience it has proven itself to be beneficial and effective. The claim of its healing power in so-called surgical tuberculosis is at present admitted by the highest medical authorities. The controversy between the advocates of operative interference and the intercessors of conservative sun-air treatment in surgical tuberculous lesions has not come to a close. The adherents to the radical procedures, however, admit that heliotherapy is beneficial during the period of postoperative convalescence or as a preparatory measure in order to raise the body resistance, and to build up the patient's general condition. Surgery in an individual, especially of young age, in poor general condition, with the disease in an active stage, is but infrequently performed even by the most radical surgeons. For the increase of the patient's resistance, strengthening the general musculature and increasing the body tone, nothing equals heliotherapy, systematically administered. Preoperative solar therapy may at times favorably surprise the surgeon. It may prove beneficial beyond expectation, so that a contemplated operation may be abolished. The contention of men like Freiberg, Meyer and a score of other writers, that surgery and heliotherapy have each their special indications, must be accepted as true. Each procedure must be administered as required, not to exclude, but on the contrary, to supplement the other.

Of inestimable value has sun radiation proven itself in the calcium deficiencies, such as rickets, osteomalacia and delayed union of fractures, the healing of which is enhanced by the rise of the constitutional resistance; sun therapy is also beneficial in localized wounds of various types, such as severe traumatization of soft tissues, ulcerations due to circulatory or neurotrophic disturbance and infected wounds. Favorably influenced are many pathological conditions which are the direct result of systemic infection. Here may be mentioned chronic osteomyelitis, chronic arthritis, and lesions of syphilis refractory to specific treatment. As an orthopedic surgeon I desire to name the diseases allied with my specialty. Besides the tuberculous bone and joint affections and the chronic arthritides, heliotherapy is indicated in the deficiency diseases of the type of Osgood-Schlatter, Legg-Perthe, Freiberg, Koehler and other conditions classed as osteochondritis. Since the muscle building effect of the sun ray is an established fact ,one can and should include conditions of myositis, myasthenia and muscle atrophy and paralysis.

The sun-air-therapy must not be regarded as a specific, but as an activating agent—as a generalized therapy. Its administration must be based upon the assumption that the local lesion is but a manifestation of a constitutional disease or deficiency. On the basis of this assumption, heliotherapy must be adopted as an adjunct to other recognized methods of treatment.

PHYSIOLOGICAL EFFECTS

It is the experience of all advocates of systemic heliotherapy that the patients confined indoors, in general hospitals under the best surgical and medical care, do not improve as rap-

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idly as when inhabiting institutions where the only additional treatment is the exposure of the naked body to the sun and air. This observation raises a demand for an explanation of the general effects of this therapeutic adjunct.

The body metabolism is enhanced, as evidenced by an increase in appetite, kidney and skin functions, depth of breathing and a rise of the cholesterol content of the blood.* These signs manifest themselves not later than two weeks after exposures have been initiated.

The influence on metabolism augments the defences of the body to better defend itself and to extinguish the infections which are apt to give rise to local lesions.

The beneficial action of solar radiation is primarily noticeable on the skin, which pigments early. It changes from a red to a copper color and finally becomes chocolate brown. Surface eruptions and ulcerations heal and the skin assumes a velvety and smooth appearance. Its enhanced function is evidenced by more vigorous sweating, an index that toxins are freely eliminated.

The muscular system is strengthened. The patient, although physically inactive, under the treatment assumes an athletic appearance; the muscles harden and gain in volume. According to Rollier, sun-rays are the "best muscle builders."

MODE OF ADMINISTRATION

The profitable effects are elicited only if the proper dosage of radiation is administered. Overstimulation is apt to occur if the treatment is not individualized and not carefully supervised. There may be symptoms of a constitutional or local character. Erythema solare with its annoying itching and burning may be the initial warning. Fatigue, weakness, dizziness, nausea and headaches, as well as a rise in temperature, which is longer lasting than the transient temperature elevation of maximum half an hour, are constitutional indications of overstepping the limit of tolerance. The axiom should be: mild stimulation furthers, severe—kills cell function. Whether strictly adhering to the methods of Rollier, of De Grosso or that of others, this rule should not be transgressed. Patience is the greatest virtue in applying this mode of therapy. The desire for quick action has frequently punished a patient with signs of overstimulation. This precludes the continuation of the exposure until the local and general symptoms have abated. To develop a tolerance to the sun and air, the air bath habit must be established before the sun rays are allowed to play on the nude body. The body must be trained to solar exposure, which will be invigorating, when gradually administered and exhausting and depressing when suddenly applied.

Air baths are begun with five minutes daily and the time is increased gradually until a maximum is reached; a tolerance to the temperature of the air is created. Only then should the sun-rays be introduced, beginning with small doses and slowly increasing the dosage to the maximum of tolerance. Whatever system is instituted, individualization must be practiced, since there are individuals who are very slow in acquiring a tolerance, and manifest, even with small doses, unfavorable symptoms indicating overstimulation. If the latter are too strongly evidenced and become annoying or alarming, the exposures should be discontinued for a few days. They should then be resumed in smaller doses and in the same systematic manner as previously administered. Should symptoms, even after temporary interruption, not recede, radiation must be entirely abolished, and its place taken by air baths until such a time as it may be again attempted.

Individualization in time and mode of exposure must be the rule at all times. The indication of tolerance is best noticeable on the skin; erythema solare or even skin reddening can serve as a criterion when to shorten or to interrupt the radiation. This red sign of warning should be guarded against by careful supervision of exposure.

CHOICE OF LOCALITY FOR HELIOTHERAPY

Wherever the sun shines, its rays can be utilized for therapeutic purposes. It is only the number of sunny days and the freedom of fog and dust in the air which must be considered in selecting the site. The Alpine heights and the

*K. C. Spence, Brit. J. Actinotherapy, 3:145-166, Nov., 1928.

seashore levels, both of which have their strong and internationally famous advocates, are useful only if weighed from this viewpoint: the purity of the air and the intensity of the sunshine. Southern California offers an ideal location for sun-air sanitaria for here the sunshine is present throughout the year. The climate is ideal, for the temperature is not too high nor too low; a gentle and pleasant breeze can be had by a careful choice of site. The recourse to artificial light in my locality La Crescenta is not necessary since even during the winter months sun radiation is available a few hours a day, except, of course, in the limited number of days when the sky is overcast with clouds. Most of the rain, however, falls in the night time, allowing the sun to appear a short interval during the day hours. when clouds or fogs prevail, the exposure to the air is practiced, irrespective of sunshine.

The tonic effect of air is probably of equal value as that of the sunlight. The patient is not chilled because of the warm temperature and the absence of cold winds. The protection against wind is afforded, on my site, by the natural sheltering hills, while the hot sun of the summer is tempered by the breeze which plays in the oak trees covering the ground.

CONCLUSIONS

Heliotherapy should be considered as a therapeutic agent of far reaching usefulness. It is not a panacea and should not exclude acknowledged surgical and medical measures. On the contrary, its applications in tuberculous lesions of the osseous system should be supervised by a person trained in orthopedic surgery in order to guard against or to overcome existing malformations. Its administration should be according to a flexible system which is adaptable to each individual case; it should never be used in a pattern-like fashion.

1244 Roosevelt building.

A NEGLECTED FOCUS OF INFECTION*

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The cervix uteri is a site of chronic focal infection, which in respect to the frequency of occurrence of important systemic consequences, ranks next only to the teeth and tonsils. The mention of chronic cervicitis is limited largely to gynecological literature; and in clinical practice this condition receives notices almost only from the gynecologist. Yet it is a subject of tremendous importance in general medicine and surgery.

The writer has accumulated records of a series of cases of serious systemic disease secondary to focal infection in the cervix. The data present strong evidence that the following conditions are attributable to this focus, the frequency of occurrence being in the order given, the most frequent are at the top of the list:

Nephritis, chiefly of the focal glomerular type;

The hypometabolic condition, not as yet scientifically named, but well recognized; characterized by hypothermia, leukopenia, underweight, subnormal basal metabolic rate, lowered resistance to disease.

Heart: Carditis and endocarditis.

Neuritis, especially sacrosciatic neuritis.

Joints: acute and chronic mono- and polyarthritis.

Peptic ulcer.

Bacteriological investigations in these cases were undertaken with a view to determining what pathogenic organisms were most commonly present. The following were found, the frequency of occurrence varying with the position in the list from above downwards:

Streptococcus group.
Staphylococcus group.
B. coli.
Gonococcus.
B. Welchii.

Other organisms are mentioned by different writers on the subject. Numerous organisms whose pathogenicity has not been demonstrated, were found, but are not named here.

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The above mentioned systemic conditions or diseases of distant parts of the body, do not naturally come to the attention of the man specializing in gynecology. They get into the hands of the general practitioner, the general surgeon, or the internist. Unless these men have in mind fully the responsibility of the cervix as an etiological factor in the above conditions, this focus is overlooked in many cases. On the other hand, leukorrhea and the symptoms produced in the pelvis and lower abdomen by chronic cervicitis either reflexly or through pelvic congestion, frequently come directly to the gynecologist, and the etiology is quickly found.

The surgeon or internist, searching for the etiology of such conditions as are generally known to arise from chronic focal infection, must be fully conscious of the role played by the cervix in these cases. He must think of the cervix as a possibility as quickly as he thinks of the teeth, tonsils, sinuses, middle ear, etc., and he must give to this possibility the same amount of painstaking search and study.

The cervical canal and cervical mucous glands are an ideal incubating place for infecting organisms. There is sufficient drainage present to prevent abscess formation and walling-off, yet not sufficient to remove the infection. If no drainage were present naturally, the condition would become acute and claim intervention by urgent focal symptoms. If thorough drainage were present, the infection could not remain there. Optimum conditions prevail for growth of organisms, and for the absorption of organisms and their products. When the infection has once become established, the constant irritation results in a vasodilatation and a relative circulatory stasis that is particularly favorable for the absorption of toxins and organisms.

The gross appearance of such a cervix is as follows: It is enlarged; relatively soft in the earlier stages, becoming hard with time. The early enlargement is due partly to congestion and edema, and partly to enlargement of numerous mucous glands. The late enlargement is due to fibrous tissue proliferation. The enlarged mucous glands show up as red points around the os, with variable density of distribution and extending to a veritable distance from the os toward the periphery of the cervical disk. The glands themselves are not grossly visible; what we see is the hyperemic area surrounding the gland. Microscopic sections of these areas show distension of the gland acini, which are filled with debris and organisms; distension of epithelial cells with mucus, and a surrounding area of vasodilatation and infiltration with inflammatory cells usually of the mononuclear type.

In the more advanced stages, the mucous membrane is intensely congested or inflamed, thick and swollen, and finally destroyed, leaving a denuded surface. The mucous membrane within the cervical canal feels soft and spongy to a probe, and bleeds readily.

More or less leukorrheal discharge is always present; usually it is profuse. It may vary all the way from a clear, mucous consistency to a thick, yellow, purulent material. Microscopically, smears from the discharge contain mucus, vaginal epithelium, cervical epithelium, leukocytes or pus, and organisms, among which the saprophytic forms predominate. In general, pathogenic forms are recognizable chiefly on culture.

The treatment of the moderate stages of this condition have up to date been ill-defined, uncertain, and lacking in effectiveness. Tampons with counterirritant or hygroscopic drugs have been the chief weapon. If definite anatomical changes have not yet occurred in the cervix, tampon treatment with iodin, glycerin, magnesium sulphate, and similar substances, may turn the tide of the infection and give the necessary impulse toward recovery. In actual practice, such cases are in the minority.

The cervix is a region that does not readily call attention to itself. The patient does not realize there is anything wrong there, and it is not being investigated by the majority of practitioners with sufficient thoroughness. Before a cervicitis comes to examination, it has usually progressed to stages in which extensive tissue changes have occurred. Such tissue changes can no longer be brought back to the original state by drugs on tampons. Any relief that is thus obtained is slight and temporary and particularly ineffective in stopping the absorption

of toxins and organisms responsible for distant effects.

Consequently, surgery is frequently called upon to deal with these cases. The focal infection is eradicated in the same way that it is in the case of the tonsil, by amputation. Amputation has at least the merit of being effective.

However, any method which will retain the effectiveness of amputation, and do away with some of its dangers and inconveniences, such as those connected with anesthesia and the postoperative stay in the hospital, will be welcomed by the majority of the patients of today. Such a method is found in electrocoagulation.

By means of the bipolar high frequency current such as is obtainable from any good diathermy apparatus, the diseased tissue can be thoroughly eradicated. The writer, after having done a considerable amount of this work, feels that it has the following advantages:

It is not major surgery; (perhaps it can be classified under the new caption of "medical surgery"); it can be done in an office, with only nominal aseptic precautions; there is no shock; the patient can get up and go home, and does not need to remain in bed.

The following are a few points in technic, based on the writer's experience with the method:

The indifferent electrode may be an ordinary autocondensation handle held in the hands;

No local anesthetic is required. The patient's only sensation is one of heat; if the current is not continued too long, this does not become unbearable.

It is best to use an aluminum needle heavily insulated to within an inch of its point; for the touch of an active electrode on the vaginal wall is exceedingly painful.

It is wiser to coagulate moderately at one sitting, and check up on the patient in ten days and repeat if necessary. Continue the "treatments" until all of the diseased tissue has been destroyed and replaced by healthy growth. This may require several repetitions.

For a week following the coagulation, the patient has a profuse and offensive discharge. Douches of strong sodium bicarbonate or chlorazene solution twice a day are quite sufficient to keep the region clear; and can be taken by the patient at her home.

Healing is usually complete in ten days.

SUMMARY

1. Attention is called to the importance of chronic uterine cervicitis as a focus of infection producing systemic disease.

2. A convenient office method is suggested for radical removal of the diseased tissue.

THE SPHERE GAP VOLTMETER*

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In the present day roentgen laboratory one hears a great deal of discussion regarding the applications of the sphere gap voltmeter. This is particularly true in laboratories where any appreciable amount of therapy is done. Most manufacturers now-a-days equip their apparatus designed for therapeutic purposes with a sphere gap, the argument being that the sphere gap voltmeter is by far more accurate than the point gap or needle point gap, as it is sometimes called.

It is true that the sphere gap is more accurate than needle points. However, not every type of sphere gap can be relied upon; neither can the claim that they are more accurate than the point gap be substantiated in all instances. A sphere gap, in the proper hands, is an ideal instrument; but if used promiscuously, it is no more accurate than the needle point gap, and

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in many instances less so. The reason for many inaccuracies is due to the fact that the operators of these instruments do not fully understand the best methods of operation, calculations, and most of all, how the readings may be accurately converted into actual and corrected kilovolts. Too often the results are only approximated.

If an operator goes to the trouble of measuring a given series of wave lengths with a spectroscope, or the intensity with ionization apparatus, it would seem that the K. V. P. should be determined with equal deliberation.

It is true that by the application of a simple formula, the K. V. of an x-ray machine may be determined from the wave length; but the laboratories in question do not possess such elaborate apparatus, and since only a sphere gap has been provided, we shall have to confine our thesis to this particular instrument.

At the outset of this discussion we desire to say that it is not the purpose of this paper to argue for or against any particular apparatus, but if possible, provide data such as will assist those owning these instruments to get the very best results possible in their work.

THE POINT GAP

The point gap, as is already known, is a device provided with two points for the purpose of measuring high voltage. It is subject to many errors, however, and cannot be regarded as a reliable device for voltages beyond 30,000 to 40,000 volts. The chief objection is that, owing to the sharpness of the points, a glow discharge, termed "corona," forms at voltages much below that of breakdown. Due to the fact that this discharge ionizes the air there is a tendency to irregularities in the breakdown voltage. Other disadvantages of the point spark gap are: sensitivity to objects near it—even the supports must be kept a good distance away. The length of the gap for a given voltage may vary with the sharpness of the points; in higher voltages there is a definite influence of humidity and discharge frequency upon it.

THE SPHERE GAP

The sphere gap as defined by the American Institute of Electrical Engineers is as follows:

"The standard sphere spark gap shall be between two suitably mounted spheres. No extraneous body or external part of the circuit shall be nearer the spheres than twice their diameter.

"The shanks shall be not greater in diameter than one-fifth the sphere diameter. Metal collars, etc., through which the shanks extend, shall be as small as practicable and shall not, during any measurement, come closer to the sphere than the maximum gap length used in the measurement.

"The sphere diameter should not vary more than 0.1 per cent, and the curvature measured by a spherometer should not vary more than 1 per cent from that of a true sphere of the required diameter."

SPHERE GAP SPARKING DISTANCES

The sparking distance between spheres for various r.m.s. (root mean square) sinusoidal voltages shall be as shown in Tables I and II.

TABLE NO. 1

Kilovolts (Average)	Both Spheres Insulated.
10	"
20	"
30	14.1
40	19.1
50	24.4
60	30.
70	36.
80	42.
90	49.
100	55.
120	71.
140	88.
160	110.
180	138.
200	138.

Sphere gap spark over voltages. 25 degrees C. and 760 mm. barometric pressure. Sparking distance in millimeters.

12.5 cm. spheres.

TABLE NO. 2

Centimeters.	Inches.	K. V. P. Spark over.	K. V. (Effective calculated by ratio).
1.41	0.554	42.4	30
1.91	0.752	56.5	40
2.44	0.961	70.7	50
3.00	1.181	84.9	60
3.60	1.418	99.0	70
4.20	1.654	113.2	80
4.90	1.928	127.4	90
5.60	2.200	141.5	100
7.97	3.140	169.8	120
10.80	4.250	198.0	140
15.00	5.910	226.2	160

At 25 degrees C. and 760 mm. barometric pressure — spheres 12.5 cm. One sphere grounded.

The voltage values in Table II are based upon the assumption of a sine wave, in which case the ratio of the effective r.m.s. voltage, to the peak voltage is:

$$\frac{1}{\sqrt{2}} = .707$$

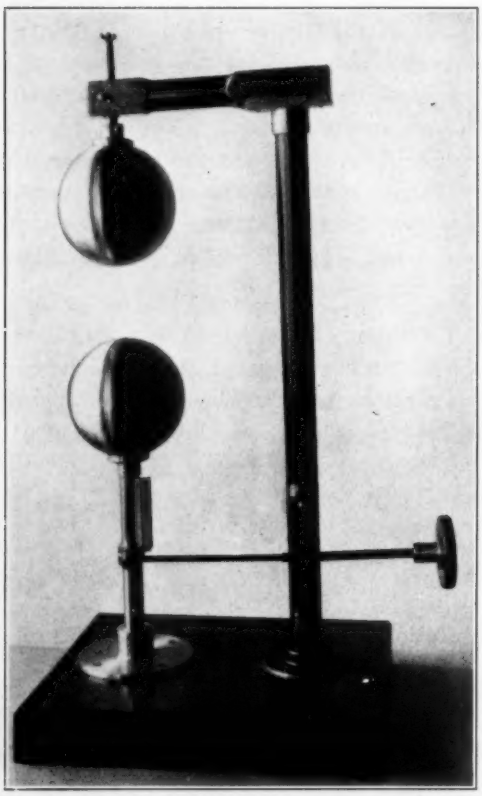


Fig. 1.

Fig. 1 is an illustration of the author's portable sphere gap voltmeter. This instrument may be described as follows: A base is provided measuring 11¾ inches by 14 inches by 2 inches; a supporting rod to accommodate pinion, and support upper sphere measures 1⅜ inches in diameter by 18 inches in length—heighth over all—25 inches. The lower sphere is supported by a brass rod mounted on a flange 5 inches in diameter—the length of the rod being 6½ inches. The brass support is provided with pinion wheel and indicator (in both inches and centimeters). The lower sphere is adjustable by means of a worm gear, and any known distance may be accurately obtained. The spheres are made of spun brass 12.5 cms. in diameter. Provision is made for connection into the high tension circuit by means of a "thumb screw" binding post on the brass flange, and also a binding post of similar construction at the top of the support of the upper sphere; the support measures ½ inch in diameter by 4½ inches in length.

Comparative values of a 12.5 cm. sphere gap with those on a calibrated electrostatic voltmeter may be recorded as follows:

TABLE NO. 3

Spark between 12.5 cm. spheres	Electrostatic voltmeter
90,000	88,000— 90,000
100,000	100,000—101,000
110,000	109,000—111,000
120,000	120,000—122,000
130,000	128,000—131,000
140,000	138,000—140,000
150,000	148,000—149,000
160,000	156,000—158,000

Table III shows that the difference in potential given by measurement with a 12.5 cm. sphere spark gap practically agrees with that indicated by the calibrated electrostatic voltmeter. The frequency and sine wave shape have no appreciable effect in the case of the sphere gap and the effects of atmospheric conditions may be corrected by certain correction factors to be given later in this thesis.

Table No. IV provides a description of spark gap voltages.

The operation of the sphere gap as illustrated in Fig. 1 is very simple. The sphere gap consists of two hollow brass spheres 12.5 cm. in diameter, mounted one above the other. The upper one is insulated by means of supports of paraffined wood, and is connected to the high tension line.

The sphere gap should have no extraneous body or external part of the circuit near the gap, that is, nearer than twice the diameter of the spheres, or at least ten inches. It should be at least 75 cm., or 30 inches above the floor or ground. Parts of the connecting circuit should be kept away from the gap between the spheres so as not to distort the electric field.

It is not necessary to keep the spheres highly polished, but care should be exercised in keeping them free from dust. When the dis-

TABLE NO. 4
SPARK GAP VOLTAGES

—Needle Points— Kilo Volts Peak.	Cm. Gap.	Inches Gap.	Diameter of Spheres 2.5 cm.	5 cm.	10 cm.	25 cm.	50 cm.
5	(0.42)	(0.17)	(0.13)	(0.15)	(0.15)	(0.16)	(0.17)
10	(0.85)	(0.33)	0.27	0.29	3.30	0.32	0.33
15	1.30	0.51	0.42	0.44	0.46	0.48	0.50
20	1.75	0.69	0.58	0.60	0.62	0.64	0.67
25	2.20	0.87	0.76	0.77	0.78	0.81	0.84
30	2.69	1.06	0.95	0.94	0.95	0.98	1.01
35	3.20	1.26	1.17	1.12	1.12	1.15	1.18
40	3.91	1.50	1.41	1.30	1.29	1.32	1.35
45	4.49	1.77	1.68	1.50	1.47	1.49	1.52
50	5.20	2.05	2.00	1.71	1.65	1.66	1.69
60	6.81	2.68	2.82	2.17	2.02	2.01	2.04
70	8.81	3.47	(4.05)	2.68	2.42	2.37	2.39
80	(11.1)	(4.36)	.....	3.26	2.84	2.74	2.75
90	(13.3)	(5.23)	.....	3.94	3.28	3.11	3.10
100	(15.5)	(6.10)	.....	4.77	3.75	3.49	3.46
110	(17.7)	(6.96)	.....	5.79	4.25	3.88	3.83
120	(19.8)	(7.81)	.....	(7.07)	4.78	4.28	4.20
130	(22.0)	(8.65)	.....	.....	5.35	4.69	4.57
140	(24.1)	(9.48)	.....	.....	5.97	5.10	4.94
150	(26.1)	(10.3)	.....	.....	6.64	5.52	5.32
160	(28.1)	(11.1)	.....	.....	7.37	5.95	5.70
170	(30.1)	(11.9)	.....	.....	8.16	6.39	6.09
180	(32.0)	(12.6)	.....	.....	9.03	6.84	6.48
190	(33.9)	(13.3)	.....	.....	10.0	7.30	6.88
200	(35.7)	(14.0)	.....	.....	11.1	7.76	7.28
210	(37.6)	(14.8)	.....	.....	(12.3)	8.25	7.68
220	(39.5)	(15.5)	.....	.....	(13.7)	8.73	8.09
230	(41.4)	(16.3)	.....	.....	(15.3)	9.24	8.50
240	(43.3)	(17.0)	.....	.....	.....	9.76	8.92
250	(45.2)	(17.8)	.....	.....	.....	10.3	9.34

tance between the spheres is greater than the diameter of one of them, or about five inches, the readings are not accurate. It is advisable to use a resistance of ten megohms between the upper sphere and the high tension line in case the electrical equipment will not stand the heavy current that results when an arc forms. The readings obtained with such a resistance will vary with the value of the resistance only when the resistance damps some of the surge waves. It is also well to remember in the operation of the sphere gap that care must be exercised to protect the milliampere meter from damage when the arc occurs across the gap. The reading in milliamperes may be determined with the meter before the sphere gap is closed. Upon closing the gap the milliammeter should be shunted as shown in Fig. 2.

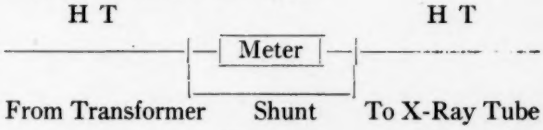
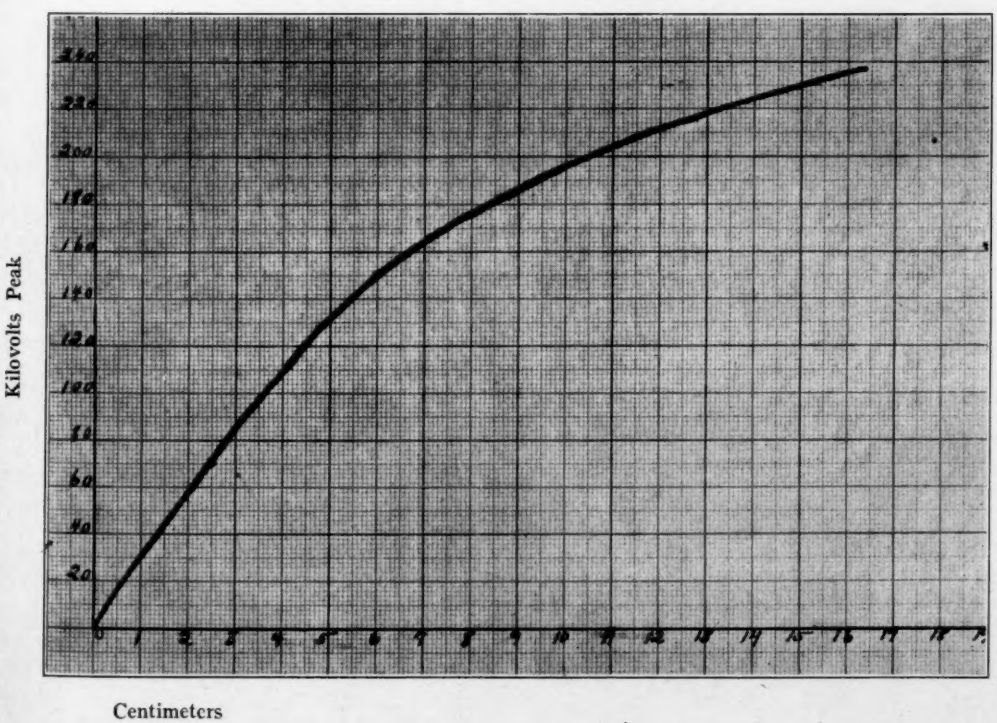


FIGURE II

METHOD OF OPERATION

1. Select a suitable place for mounting the sphere gap voltmeter, bearing in mind the conditions previously described. The instrument should be so mounted that the scale will be on a level with the eyes of the operator. By ob-



Curve 1. Sphere gap sparkover voltages at 25° C. and 760 mm. barometer spheres 12.5 cm. in diameter, one sphere grounded.

serving this rule there is less danger of the operator coming in contact with the upper sphere, which is at high voltage when the instrument is in use.

2. The operator should keep clear of the upper sphere when the instrument is in use, as the voltage is high enough and the available power sufficient to cause severe injury.

3. Ground the lower sphere.

4. The lower sphere is moved upward until the indicator points to zero on the scale.

5. The upper sphere is adjusted so that it just touches the lower sphere. As the lower sphere is moved the indicator will show the distance between spheres.

6. The upper sphere is then ready to be connected to the high tension circuit, the voltage of which is to be measured. This should be done while the power is turned off.

7. The worm gear should be gradually moved upward until a spark occurs between the two spheres. The reading of the pointer should then be noted, whereupon the lower sphere should again be lowered so as to break the discharge. Several observations should be made and the average reading taken.

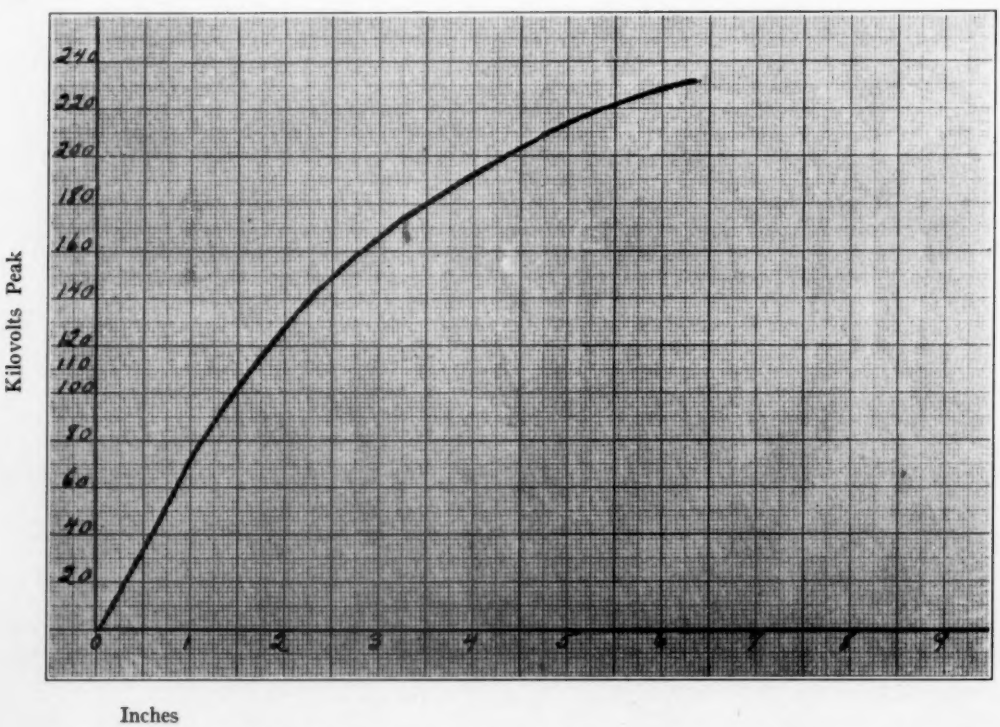
8. Apply the above average reading to curves number 1 or number 2, depending whether the scale is read in centimeters or in inches. In this way the peak or spark over voltage is obtained. When the instrument is used at high altitudes, or very accurate results are required, certain corrections are necessary as outlined under the heading of "Correction Factors."

CORRECTION FACTORS

1. Determine the reading of the barometer in centimeters, and the temperature in degrees centigrade of the atmosphere in the vicinity of the sphere gap and substitute these values in the following formula:

$$D = \frac{3.92 \times b}{273 + t}$$

Multiplying the reading obtained by the value of D obtained above. For example, at 8,000 feet consider the barometer reading to be 56.03 centimeters of mercury at 25 degrees cen-



Curve 2. Sphere gap sparkover voltages at 25° C. and 760 mm. barometer pressure spheres 12.5 cm., one sphere grounded.

tigrade. Substituting these values gives the relative air density.

$$D = \frac{3.92 \times 56.03}{273 + 25} = 0.737$$

If the sphere gap reading were 3.55 centimeters, or 1.39 inches, the voltage as read from curve 1 would be 100 K. V. This multiplied by D, or 0.737, gives the preliminary reading 73,700 volts, which is further corrected as follows:

2. Should it be necessary to secure very accurate readings, which results in taking into consideration the size of the spheres, curve 4 shows this added correction. Thus, the relative air density D, as obtained by use of the above formula is referred to the curve then across to the corrected value F, as follows:

$D = 0.737$, then $F = 0.759$.

In other words, the preliminary reading of 73,700 volts now becomes 75,900 volts.

The basic principles underlying these formulæ have the following derivation:

Correction factor, D, equals relative air density. The correction factor, D, is obtained in the following manner:

If the air density at 25 degrees centigrade and a barometric pressure at 76 centimeters be taken as standard, then the relative density at other temperatures and pressures may be expressed in terms of this standard, thus:

$$w = \frac{0.00465 \times b}{273 + t} \text{ where}$$

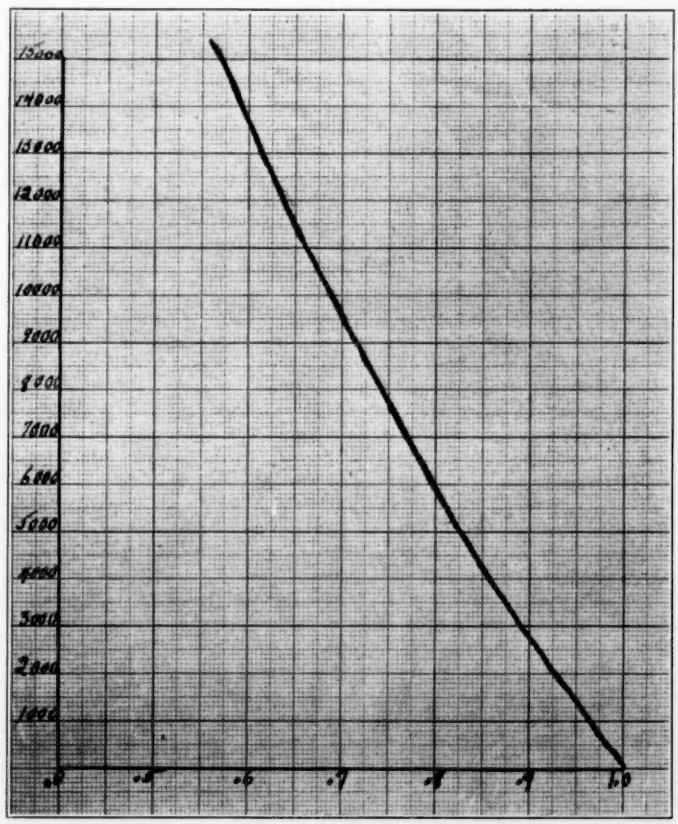
w equals the weight of air in grams per cubic centimeter.

b equals the barometric pressure in centimeters.

t equals the temperature in degrees centigrade, at 25 degrees C., and 76 centimeters pressure.

$$w = \frac{0.00465 \times 76}{273 + 25} = 0.001185$$

The ratio of the weight of air, w′, at t,



Curve 3. Relative air density. Approximate variation of air density with altitude 25° C.

centigrade, and b, cm. pressure to the above, equals:

$$\frac{w'}{w} = \frac{0.00465 \times b}{(273 + t)\ 0.001185}$$

$$= \frac{3.92 \times b}{273 + t} = D$$

For very accurate work there is also a correction factor of the air density factor which depends upon the size of the spheres. See curve 4.

For spheres 12.5 centimeters in diameter this correction is as follows:

$$D = \frac{3.92 \times 56.3}{273 + 25} = 0.737$$

This corrected value obtained by use of curve 4 gives, F = 0.759.

That is, the reading obtained by use of curves 1 or 2 is to be corrected by multiplying by 0.759. In other words, if the sphere gap reading were 3.55 centimeters or 1.39 inches, the voltage as read from curve 1 would be 100 K. V., but corrected by the factor F, would be:

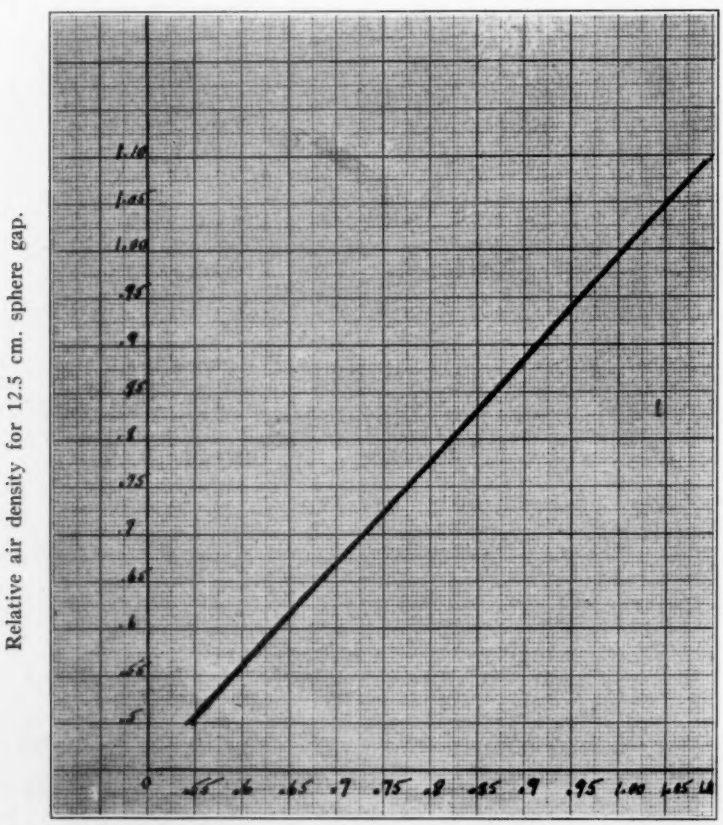
100 K. V. × 0.759 = 75.9 K. V., or 75,900 volts.

TABLE NO. 5

Relative Air Density as Calculated from above Formulae.	Corrected Air Density for 12.5 cm. sphere gap.
0.50	0.535
0.55	0.583
0.60	0.630
0.65	0.677
0.70	0.724
0.75	0.771
0.80	0.816
0.85	0.862
0.90	0.908
0.95	0.955
1.00	1.000
1.05	1.045
1.10	1.092

For example, at an elevation of 8,000 feet, consider the barometric reading to be 56.03 centimeters of mercury at 25 degrees centigrade.

The foregoing fundamentals, with but slight corrections, are sufficient to supply all the data necessary for the calibration of an x-ray machine with the sphere gap voltmeter. Ma-



Curve 4. Corrected air density for 12.5 cm. sphere gap.

chines calibrated after the curves provided will be pretty accurately measured in as much as the potential across the tube is concerned, and the operator is provided with such information as will assure him of an accurate working knowledge of his equipment.

TYPES OF SPHERE GAPS

1. An instrument provided with a scale measuring distance between spheres directly in centimeters or inches.

2. An instrument measuring directly in K. V. P.

3. An instrument measuring in K. V. P. and provided with a "magnetic needle" device.

4. An instrument measuring in K. V. P., and also in centimeters and inches.

The first named (1) is by far the most desired. With the necessary charts this type of high tension voltmeter can be used anywhere at any time, and the proper calculations made to determine the actual K. V. P.

A sphere gap reading directly in K. V. P. is not to be desired unless that particular instrument is mounted and calibrated at the particular location and altitude in which it is to be used.

An instrument provided with the "magnetic needle" device is not to be placed in the hands of the untrained. One who has had considerable experience with sphere gap voltmeters will not have so much difficulty in obtaining a reading. Such readings as are obtained with this type of apparatus, however, are obliged to be inaccurate unless the spark gap distance is measured in centimeters, or unless the instrument is calibrated for the particular locality in which it is being used.

All x-ray machines should be calibrated at the time of installation. This should be done by the manufacturer or the agency making the sale.

All installations that are calibrated should be so calculated as to include altitude, temperature and barometric pressure.

CONCLUSION

1. A sphere gap voltmeter indicating the distance between spheres in centimeters or inches so that calculations can be made therefrom is to be desired.

2. Sphere gap voltmeters are most desirable when equipped with spheres 12.5 centimeters in diameter.

3. Sphere spark gap devices should not be equipped with "magnetic needle" indicators if they are to be given into the hands of those unskilled in the technic of their operation.

4. Instruments measuring directly in kilovolts are undesirable unless they are calibrated for the particular locality in which they are to be used.

5. Sphere gap voltmeters should be provided with resistance in series with the high tension line to protect the equipment.

6. Calibration of x-ray equipment should be done by those making the installation before regular operation of the apparatus is attempted.

7. Calibration of x-ray equipment should include consideration of temperature, barometric pressure and altitude for the location in which such equipment is to be operated.

PHYSICAL THERAPY CLINICS

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CARDIAC DECOMPENSATION WITH EDEMA OF LOWER EXTREMITIES AND ASCITES

CASE No. 1. A white male, age 59, had been in the hospital several months under medical treatment for decompensation of a double heart lesion. Rest in bed and digitalis produced some improvement but reached an apparently stationary period where no further improvement was noted.

The attending physician then called us in consultation relative to the use of high frequency current in the form of medical diathermy through the liver, hoping to diminish the passive congestion in the liver and reduce the ascites.

Treatment was begun at once with diathermy through the liver daily. The medical regime was also continued. After the third treatment improvement was noted and after twenty-one treatments the edema had disappeared and the ascites had been absorbed. During the same time the liver decreased to its normal size and the heart became compensated. Within a month from the beginning of treatment the patient was able to be about the room.

Two years later the patient complained of distress in the region of the heart for which three applications of diathermy directly through the heart were made, resulting in complete relief.

The patient has had no return of the edema or ascites and is still well, five years after the treatment.

CASE No. 2. Miss M. P. Age 38, registered nurse. This patient came for treatment of precordial distress which was an accompaniment of a chronic mitral valve lesion which she has had for a number of years.

At the time she presented herself for treatment, she was suffering from a double valve lesion with decompensation accompanied by enlargement of the liver with the lower border three fingers below the costal margin and edema of the lower extremities. She was cyanotic and unable to do her work. She had been in this condition several times in the last few years and on each occasion was treated by rest in bed accompanied by digitalization. This time the precordial pain was much greater than on previous occasions.

Medical diathermia was used directly through the heart area with one electrode 15 x 20 cm. in size, directly over the precordial region and another of equal size directly opposite on the back. With this size of electrode the patient was able to tolerate 1200 ma. of current. The first treatment continued twenty minutes. Thereafter we were able to prolong the treatment to thirty minutes each time and in most cases to increase the milliamperage from 1200 to 1600.

Immediately after the first treatment she was relieved of the precordial distress and within a few days the edema of the legs had disappeared and within a week the liver had returned to its normal size. She was also relieved from her dyspnea but the cyanosis continued in a mild degree.

She was in charge of a hospital for crippled children where there were about 40 patients and during the winter of 1928 and 29, at one time for one week, all of her help were ill except herself, a cook and the engineer. In spite of this extra labor, she has continued working without any rest in bed during the entire season, something which has not been possible for a number of years past.

Since the first treatment there has been entire absence of precordial pain.

CARCINOMA OF LIVER WITH ASCITES

CASE No. 3. Mrs. P. E. J. Age 28, married, came complaining of several shot like nodules in the skin of the right anterior chest wall.

She had had the right breast amputated five months previously because of carcinoma. She had remained well until six weeks ago when she noticed one or two nodules. These slowly enlarged and others appeared until at the time of my first examination she had about 20 nodules, which felt hard, were slightly movable and measured about five mm. in diameter.

Following an erythema dose of low voltage x-ray these nodules disappeared and the patient left my care.

Six months later she returned complaining of feeling weak and being unable to keep up her work as prima donna with a theatrical troupe.

Examination revealed fluid in the abdomen, the liver was palpable, felt hard and nodular and extended down to the umbilicus below the right costal margin.

Several new shot-like nodules were found in the skin of the right anterior chest wall.

The patient entered the hospital at once where low voltage x-ray treatment was given over the skin nodules. Rest in bed with withdrawal of liquid from the diet and the employment of saline cathartics failed to reduce the fluid. On the contrary the amount increased, the liver enlarged and the patient suffered severe pain through the liver into the back.

Diathermy was employed primarily to relieve the pain through the liver and back. Much to our pleasure the fluid in the abdomen rapidly reduced until no longer demonstrable. During two months' time the patient received nineteen treatments. The first three treatments consisted of 1000 ma. for twenty minutes each, while the remaining 16 consisted of 1500 ma. for forty minutes.

A block tin electrode 15 by 20 cm. in size was placed in close contact with the skin of the back over the area opposite the liver while a mesh electrode of the same size was used in front over the liver. The mesh electrode conformed to the irregularities of the surface better than the tin.

Following the first treatment the pain rapidly disappeared and within a few days the fluid in the abdomen rapidly lessened. At the same time the liver reduced in size until only 5 cm. below the costal margin. The patient was able to walk about the hospital each day for a period of several months when gradual loss of strength made this impossible.

This case illustrates the great palliative value of diathermy in a patient suffering from incurable malignancy of the liver secondary to cancer of the breast. So complete was the relief from pain that morphine was never required and only occasionally was a half grain tablet of codeine used.

The liver remained of the same size which it assumed after the treatments were given. The fluid did not reaccumulate until shortly before her death. It would seem then that in this particular case, the high frequency current gave great palliation when all other methods of treatment were ineffective.

DISCUSSION

Case No. 1 and Case No. 2 illustrate the great help to be obtained in chronic cardiac cases by the use of medical diathermia. This treatment can be given without interfering with any medication which is thought necessary and as shown by these two cases is one of the greatest adjuvants which is known to medical science. It is the only thing which will so quickly relieve the precordial distress and at the same time aid the heart to better physiological function.

Case No. 3 shows how much relief may be given a patient who had much distress from ascites due to terminal malignant metastases in the liver. There is no other agent capable of producing the palliation exhibited in these three cases. Diathermia does not interfere with needed medication but on the contrary fits in with it.

EDITORIAL

ARCHIVES OF PHYSICAL THERAPY, X-RAY, RADIUM

Eighth Annual Meeting, November 4, 5, 6 and 7, 1929, Hotel Sherman, Chicago.

WHAT THINGS ARE MADE OF—I

The New Physical Concept of the Universe. It is a Composite of Three Things—Protons, Electrons, and "Photons"

By ARTHUR H. COMPTON, Ph. D.

Professor of Physics, University of Chicago. Member American Philosophical Society; National Academy of Sciences; National Research Council.

Who is there who has not asked himself, "What is this world around me?" Rocks, trees, people—what are the parts of which they are made, and how are these parts put together? Light, radio waves, x-rays — what are these radiations?

Upon such questions men have pondered since the beginning of thought. Until recently, opinions on these matters were speculative; but during the last heroic generation many of these questions have been answered with a definiteness which was unthinkable in an earlier era. It will not be possible in this brief survey to present adequately the great mass of evidence which has been collected regarding the nature of things. We shall rather discuss only a few typical experiments that tell us something about how things are made.

When we take apart this infinitely complex mechanism which we call dirt, or perhaps a diamond, or it may be a flower, we find it made up of a myriad of tiny molecules. Each of these molecules is itself complex but is more perfectly formed than the wheels of a watch, and has continued to run for billions of years without winding and without wear. We find that the molecules which make up matter in all its endless variety of forms are themselves built up of a few hundred kinds of atoms. Some of these atoms differ from each other by their chemical properties, others only in one respect, by their weights.

But we cannot stop here. Our few hundred atoms are themselves made of yet more tiny particles. It is as sung by the poet Pope:

> "The larger fleas have smaller fleas
> Upon their backs to bite 'em.
> These smaller fleas have other fleas,
> And so ad infinitum."

These tiny particles show themselves through their electric charges. There are found to be two kinds of them, carrying positive and negative electric charges, respectively. But as nearly as we can tell, all those of any one kind are exactly alike. The positively charged particles, called *protons,* have most of the weight of the atom, while the negatively charged particles, or *electrons,* are the lively little bodies responsible for chemical combinations, electrical conductivity, and the like. By grouping themselves in various ways these little particles form the various atoms.

Rocks and trees and people do not, however, make up the whole of the universe. How about the sunlight that makes the trees grow and gives us warmth? Newton wrote of light as consisting of little particles or corpuscles. Huyghens and Fresnel explained its properties in terms of waves, and Maxwell, by introducing the idea that these waves are electromagnetic, foreshadowed the recent developments in x-rays and radio. But recently Einstein has brought back a modified conception of Newton's light corpuscles, now called *photons,* and evidence for their existence has become convincing.

At the present moment, light is the darkest of the physicist's problems. It seems that we can prove that it consists of waves; but we can also show that it consists of little particles. The two conclusions cannot really be inconsistent; but how light can consist of waves and at the same time of tiny particles is as yet an unsolved riddle.—Scientific American, Feb., 1929.

LIFE MEMBERSHIPS

At the 1928 fall convention of the College, resolutions were adopted for the establishment of life memberships. Twenty such memberships were subscribed for at the time without solicitation. The purpose of these memberships was to create a sufficient fund in the treasury to take care of certain obligations which have accrued, and also to assure sufficient means of carrying on the administration of college affairs during 1929. The resolution provided that a member be free from his dues for his lifetime, but be obligated only for the payment of his annual subscription to the journal. Unfortunately the meeting at which this resolution was passed and adopted was held on the last day of the convention, after many of the fellows had already left for their homes. No announcement has been made until the present of the adoption of the resolution, and in order to apprise fellows of the college that such a resolution has been duly passed upon, this notice is given.

Fellows of the college who wish to take the opportunity to become life members are asked to correspond with the executive secretary, suite 716, 30 North Michigan Avenue, Chicago, for full details of the plan.

LUMINOUS RADIATION

That luminous radiation plays an important and favorable role in the treatment of many pathologic conditions has been attested by years of clinical observations. Within its border is to be found heat, light and the near ultraviolet rays. Each of these regions which may be obtained by artificial means or from the natural source—the sun, promote definite physiologic responses. The present decade has observed a notable shift in the popularity of phototherapy towards ultraviolet radiation. The tendency is attributed to all of the virtues of luminous radiation towards this part of the spectrum. In our enthusiasm for this form of treatment there is an inclination to overplay one side of the spectrum and to neglect the virtues of the other. It must not be forgotten that photo and heliotherapy have demonstrated their value in the court of experience. Wherever they are indicated nothing can supersede them. Within its limits it combines natural heat rays, light rays and biologic ultraviolet rays. All of these spectral regions have a biologic role in the maintainence of life and health. From the evidence at hand it is apparent that heat radiation is a vital necessity to living matter. According to Sonne, visible heat rays are more sedative, pentrate deeper and produce more profound physiologic action. This observation has recently been confirmed by Hill and Campbell, who demonstrated that skin and subcutaneous tissues were able to tolerate a higher degree of visible heat (47½C) than infra red radiation (43° C.)

The visible spectrum plays a biologic role of no less importance. According to Langley, 19% of the sun's radiation consists of electro-magnetic waves that link the infra red to the actinic region. It has a vital purpose in our environment, as it influences in some unexplainable manner the photo-luminescent material found in living structure. Nature may be said to be prolific, but it is never wasteful. Visible radiation acts as a catalytic agent to these substances in order to promote vital function. Vital activity is depressed or activated in proportion to the amount of visible light present in its immediate environment.

Evidence is not absent that photochemical changes can be produced by all of the respective regions of the luminous spectrum. Anti rachitic effects and vitamin D activation have recently been demonstrated as a property of infra red and visible radiation. To obtain these effects it is only necessary to make practical application of the Bunsen-Roscoe law and to recall that the *intensity-time* (I.T.) factor holds as true in these regions as it does in radiations of the higher frequencies. It is well, therefore, to remember that life and health is dependent upon the trinity of liminous radiation.

Light radiation in the form of general baths has been found to be a useful adjuvant in practically all conditions where ultraviolet radiation is indicated. In America it is much of a neglected therapy. In the search for panaceas let us not forget the tried and proven measures.

The reader's attention is invited to the more detailed exposition on luminous radiation in this issue by one of its outstanding investigators, Prof. Carl Sonne.

D. K.

DEMONSTRATION OF RADIOACTIVITY BY MEANS OF ALPHA ELECTROSCOPE

In the examination of the organs for radioactivity I usually proceeded in the following manner: The organs after removal at autopsy were chopped up by being passed through a food chopper and dried over a sand bath to a slight charring. They were then partly incinerated in the electric oven at low heat, most of the organic matter being driven off. Bones were sawed into small pieces and organic matter was burned off in the incinerator. The organs were then placed in bottles and sealed.

Separate specimens of the various organs to be tested which had been partly incinerated were then placed in a cardboard container and put in the lower compartment of an alpha electroscope of the Lind type. The various readings were then made, the normal leak always being taken before each test. The normal leak was usually considered the time it took the foil to go across the entire microscopic scale.

The following protocol illustrates one of these tests.

Liver.—Normal leak, two minutes and twenty seconds; test, two minutes.

Spleen.—Normal leak, two minutes and twenty-one seconds; test, twenty-six seconds.

Bone Cortex.—Normal leak, two minutes and eighteen seconds; test one minute and twenty-one seconds.

Bone Marrow.—Normal leak, two minutes and eighteen seconds; test, one minute and fifteen seconds.

From this protocol it is seen that the bones contain by far the most radioactivity, the spleen a definite amount, and the liver a trace. After the test was made all the material, including the inferior maxilla and the two femurs, was then placed near the gamma electrometer and the following readings were made:

Normal leak, twenty-eight minutes; test, twenty-two minutes and forty-three seconds.—J. A. M. A., 92:557, Febr. 16, 1929.

RADIOTHERAPY

A report on the medical uses of radium has been published by the medical research council. It consists of a summary of results prepared by the radiology committee of the council, and is based on the reports on the year's work submitted by a number of participating institutions; namely, the Middlesex Hospital, University College Hospital, St. Bartholomew's Hospital, King's College Hospital, the London Hospital, St. Peter's Hospital,London, the London Association of the Medical Women's Federation (radium for use in a group of hospitals). the General Hospital, Birmingham, The Royal Infirmary, Cardiff, the Royal Infirmary, Aberdeen, and the Irish radium committee of Dublin. The report points out that the intensities of the radium foci have in many cases been reduced gradually, with a corresponding prolongation of the time of exposure. In some forms of cancer a definite method of treatment has been arrived at: Any woman suffering from early carcinoma of the cervix uteri can have the disease locally removed by means of a definitely planned course of radium treatment as surely as by surgical means, or a man with a malignant growth of the tongue can likewise have the disease locally cured. In the latter case, even if the growth should have extended to the glands, radiosurgical methods would offer a good prospect of eradicating the disease.—J. A. M. A., 92:572, Febr. 16, 1929.

A BIOLOGICAL MEASURE OF X-RAY DOSAGE

Charles Packard, in the Journal of Cancer Research, describes his experimental work on the lethal effects of x-rays on the eggs of *Drosophila* (the fruit fly). He found that when the intensity of the x-rays was 0.10 erythema dose per second or greater and when the wave length lay between 0.20 and 0.70 angstrom units, the biological effect was correlated with the dosage expressed in roentgen units. This does not imply that the two are parallel. That is, if 50 per cent of the eggs are killed by 180 roentgen units, it cannot be held that 100 per cent will be killed by 300 units. It is found that 75 per cent of the eggs hatch after a dose of 130 roentgen units, 50 per cent after a dose of 118 and 25 per cent after a dose of 300. The death ray is independent of the quality of the beam within the limits of wave length investigated. So that it follows that any x-ray beam composed of homo-

geneous or heterogeneous rays within these limits which kill, for example, 50 per cent of the eggs is delivered by 118 roentgen units. The actual work is carried out as follows: The eggs are placed at the desired distance from the target and portions are removed at regular intervals, which may be five, ten or fifteen minutes when the intensity is high or even twice as long when the intensity is lower. The longest exposure should kill more than half the eggs; several hundred eggs should be treated for each length of exposure. If it is found that one-half of the eggs are killed in ten minutes, the dose at the distance used is 18 roentgen units per minute and in this way the number of roentgen units delivered in any length of exposure can be found if the distance at which the eggs are placed from the target is taken into consideration.

ANTI-MICROBIC PROPERTIES OF RIVER AND SEA WATER

(Critic and Guide, July, 1926.)

The correspondent to the Lancet (London, February 28th, 1925) writes from Paris of an address read to the Academy of Medicine by Dr. Arloing, professor of experimental and comparative medicine and of bacteriology at Lyons.

From a study of the waters of the Rhone, the Saone, the Isere, the Brac, the Romanche, the estuary of the Seine, and the harbor of Le Havre, he found that these waters had remarkable bactericidal properties with respect to certain organisms of the intestinal group. Dr. Arloing attributes these properties to a bacteriophagic and bacteriolytic action of the water, varying with its regional source.

Thus the Rhone and the Isere have a marked antipathy towards the typhoid organisms, the Isere and other streams in the neighborhood of Grenoble, including water from melted snow, having a particularly destructive action on paratyphoid A, while the waters at Le Havre are inimical to the bacillus dysenterae.

The bacteriolytic effect on the B. coli is the most general, and this is found particularly in slow-flowing, impure water (Saone, Seine, and in the harbor of Le Havre).

The anti-microbic action is usually more marked below than above an important locality.

This bacteriolytic property, from its biological character, seems to be bacteriological rather than physico-chemical.

THE QUESTION OF PROTECTION MEASURES IN X-RAY LABORATORIES IN HUNGARY

The Royal Hungarian Minister for Public Welfare and Labor called a conference on the subject of x-ray and high-current prophylaxis.

This conference met under the chairmanship of the State-Secretary T. de Gyory, M. D., and set up a committee consisting of x-ray experts and engineers. The chairmen of this committee are Prof. B. Bogany and Prof. B. Kelen, M. D., the referent Prof. Adj. N. Ratkoczi, M. D.

The committee has to work out a scheme of prophylactic rules against x-ray and high current damages; to watch the scientific and technical development of radiology and to keep in touch with foreign committees of this kind. Its first meeting took place February 4th in Budapest.

INFANTILE SCURVY

R. S. Bromer, in the *American Journal of Roentgenology,* writes on the roentgen ray diagnosis of infantile scurvy. The most frequent pathological change is a subperiosteal hemorrhage especially occurring in the lower extremities. Epiphyseal separations may accompany these hemorrhages. On radiographic examination a dense band is noticed in the epiphyseal line, while next to this on the side of the shaft is the area of greatly weakened bone (decreased density). Atrophy with a "pencil-point" appearance of the neighboring cortex is seen in the ends of the shafts. In advanced cases spurs occur lateral to the ends of the diaphysis.

THE STUDENT'S LIBRARY

BOOKS RECEIVED

This column is devoted to acknowledgment of the books received. Such acknowledgment must be regarded by the sender as sufficient recognition of the courtesy until time and space permit selections to be made for review.

Textbook of Clinical Neurology. By ETAOIN TEXTBOOK OF CLINICAL NEUROLOGY. By *M. Neustaedter,* M.D., Ph. D., Clin. Prof. in Neurology, New York Pollyclinic Med. School and Hosp.; Attending Neurologist, Bellevue Hosp.; Neurologist, Kings County and City Hosp., Welfare Island, N. Y., etc. With an introduction by *Edward D. Fisher,* M. D., with 228 illustrations, some in colors. F. A. Davis Co., Publishers, Philadelphia.

BOOKS REVIEWED

DIATHERMY, ITS PRODUCTION AND USES IN MEDICINE AND SURGERY. By *Elkin P. Cumberbatch,* M. A., Bo. M. (Oxon), D. M. R. E. (Camb.) M. R. C. P. Medical officer in charge, Elec. Dept. St. Bartholomew's Hosp., etc., Exam. in Med. Electrology, Univ. of Cambridge. Former president, Sec. of Electrotherapeutics Royal Society of Medicine. Second edition, 332 pages, 87 illustrations. St. Louis: the C. V. Mosby Co., publishers, 1928.

This volume is a second edition that has been extremely revised, largely rewritten and has incorporated the proven clinical experiences of other investigators. The facts on diathermy are presented in clear and understandable style without the mathematical formulas which are so repellant to the average non-technical reader. In consequence of this easy and clear style the student and practitioner will pass through the exposition of high frequency currents with profit to himself and read with greater appreciation the chapters on the distribution of diathermy currents and the pathway these currents take through various conductors, and the degree of heat produced by the diathermy current in living and dead material.

It is the reviewer's impression that a more solid foundation, based on extensive laboratory and physiological experimentation is needed before the critical, the open minded and the intelligent members in the profession will admit its scientific and therapeutic usefulness. Comparative tests are necessary to show its superiority as a pain relieving measure over that of conductive or radiant heat. More material information is needed by laboratory experimentation as to the intrinsic absorbtive qualities of diathermy. There is still a division of opinion as to its deep heating qualities. No text on diathermy has thus far offered any definite opinion as to whether the heating factor is the all important one in the effects produced by diathermy. With the exception of a few scattered observations no evidence is present in this or any modern text on the subject as to the effect of high frequency currents on bacteria *in vivo*. There is a need for a sober check-up on all of the points raised. No intelligent critic on the subject seriously accepts the specific effect of this current on bacteria without recalling its like specificity for the cell material adjacent to the microorganisms. It it is lethal to one it is physiologically depressing to the other.

The chapter on Surgical Diathermy is beyond a doubt the most comprehensive in any language. It is most complete in exposition and in detail. The material of this portion of the book has been frankly revised and largely added to. Here is a book that is a worthy addition to the literature of medical and surgical diathermy.

DIABETES, ITS TREATMENT BY INSULIN AND DIET. Fourth revised and enlarged edition. *Orlando H. Petty,* M. D., F. A. C. P., Prof. of Diseases of Metabolism in the Graduate School of Medicine, University of Pennsylvania, Physician in charge of department of diseases of metabolism, Philadelphia General Hosp., etc. Philadelphia: F. A. Davis Company, 1928.

This small volume is a popular exposition on diabetes, its diagnosis and prevention. Insulin therapy is conservatively evaluated and the patient is informed in simple and concise language the method of its personal administration.

The dietory regime is discussed in a manner thoroughly clear to lay people. The patient is taught routine laboratory analysis. Certain foods and diets are indicated as useful to the diabetic. Stress is also placed on errors of diet that may be of direct or future harm to both the potential and tone diabetic. The nature of the disease is discussed in a style that is clear and understandable. The layman will appreciate the omission of technical terms and the simplicity of the language used. In spite of the fact that this small brochure is obviously not intended as a reference for the physicians, the busy practitioner will greatly profit by its perusal. It concisely outlines the outstanding facts on the subject of diabetes.

This small volume, brought down to date by careful revision, is a valuable addition to the non-technical literature on the subject. It fills a definite need for and will act as an intelligent laison between the patient and the physician.

INTERNATIONAL ABSTRACTS

X-Ray Diagnosis and X-Ray Treatment of Brain Tumors. Dr. A. Beclere, Paris. Presse Med., No. 64, 1928.

Simple radiography of the skull affords diagnostic information about head diseases which are independent of the brain, such as bone tumors, syphilitic osteitis; about others which indirectly depend on the brain, such as irregular thickening, strongly developed frontal cavities, acromegaly, prognathism, about such affections which are directly due to increased brain pressure, such as prolonged existence of the fontanelles, separation of the sutures in children, varicosities of the diploe, changes of the sella; and about such due to the local effect of an adjacent tumor, which it is often difficult to differentiate from syphilis or osteogenous sarcoma.

The development of radiographic technic, involving as it does the preliminary injections of contrast agents, the development of stereography, etc., are discussed in detail and critically compared. The author comes to the conclusion that as far as encephalography is concerned, the lumbar and suboccipital routes are dangerous, and that the method of Dandy of injecting air into the ventricles through a small opening in the skull made by trephining is safest and best. But the air must be injected slowly and in less quantity than the cerebral fluid which has been aspirated, and under no circumstances must it exceed 20 cubic centimeters. The author leans on Grant's studies of 400 ventriculographies, which show that in 80 per cent localization was possible, but at that ventriculography gives no information as regards the character of the tumor, and, in addition, is not a procedure free from risk, for aside of a number of disagreeable results there is a mortality of about 8 per cent. It follows that such an examination must never be undertaken except when there exists a definite indication and even then only when operation will follow within twelve hours.

As regards the treatment of brain tumors with x-rays, it is the method of choice in hypophyseal adenoma. Small doses at great intervals are the rule, but the treatments should be begun at the early stage of the growth. The author has a patient who has remained cured for twenty years. These adenomata are to be differentiated from the suprasellar tumors of Rathke's pouch which are refractory to radiation. In non-localized tumors radiotherapy is permissible provided the technic is good and applied under special precautions, but the results are uncertain, though there is a possibility of their being good. But the moment the treatment produces aggravation a decompression operation must be performed at once, after which radiation should be continued. In localized inoperable tumors or in such which permit only partial excision, radiation is indicated in a manner dictated by the sensibility of the tissues, which is ascertained by microscopic examination of the removed tissue.

Certainly in all such cases radiation has only a symptomatic effect. The best method of application is strongly filtered depth radiation at great distances and large fields of radiation. An experimental dose of 500 R. (by French gradation) is to be essayed at first, and if this dose is tolerated it must be increased to 1000 R. which, however, must not be exceeded.

In conclusion the author asserts that x-ray therapy is preferable to treatment with radium.

A Procedure in Rational Light Therapy. J. Saidman. Presse Med., 36, 34, 1928.

It is impossible to know a priori the light sensitivity of a patient. Since, however, rational light therapy is possible only when the corresponding reaction is obtained, it is advisable to determine the individual light sensitivity before beginning treatment. For this purpose the author has constructed an apparatus with 18 different openings which he places on the skin of the patient. After irradiation of various durations the openings are automatically closed. The following day it is possible to read on the given patient the exact time when the reaction appears. Erythema of the first degree should be shown in tuberculosis and anemia, of the second degree in infantile asthma, fistulas, bone and joint tuberculosis, endocrine insufficiency and nutritional disturbances, and of the third degree in skin diseases, especially psoriasis, lupus and naevi.

Contribution to the Treatment of Infantile Spinal Poliomyelitis. F. F. Lyzes. J. de Radiol. et D'Electrol., Vol. 12, 4, 1928.

The author treats infantile spinal paralysis, not exclusively according to the Bordier method, with roentgen rays, diathermy, or electricity to the atrophic musculature, but uses a "mixture" of these methods. Of 97 patients he submitted 44 to his procedure, and obtained 47.8 per cent cures, 38.6 per cent improvements and 13.6 per cent failures. His treatment consists of the following: Roentgen irradiation of the affected segments, according to Bordier's procedure, in the first stage before actual destruction has begun. Roentgen irradiation is also indicated in the second stage, if one agrees with Sherrington and Marie that the cellular accumulation is not limited to only one point, but takes place all along the spinal cord, and that the cells are found in various stages, so that some can still be favorably affected. Between the two series, diathermy treatments were given in order to improve the nutrition of the affected parts of the spinal cord,

and this was given daily for not less than 30 minutes. Care is to be taken in the strength of the current. The author uses 500 Ma. The Bucky pulsator is recommended. As many sessions are necessary as are required for obtaining the normal organ temperature. Galvanization and faradization are employed immediately after diathermy. These are not given schematically, but correspond to the individual demands. This must be employed daily and regular electrical testing should not be forgotten. Massage and mechanotherapy are also useful, but should be individualized. By these procedures considerable success was obtained which was not obtained before.

Radiotherapy of Brain Tumors. Antoine Beclere. Strahlentherapie, 31, 1, 1928.

The scientific study of radiotherapy in brain tumors necessarily depends on the anatomical location and the histologic structure of these growths.

Two very dissimilar closed spaces, which are separted from each other by a cutaneous wall, are the seat of tumors which must be considered separately; the tumors of the hypophyseal fossa and those of the large cranial cavity.

The tumors of the hypophyseal fossa are almost exclusively adenomas of an endocrine gland, of the anterior lobe of the hypophysis. They are either chromophile adenomas with gigantism or acromegaly of the skeleton or chromophobe adenomas without bone changes or mixed adenomas.

Radiotherapy is the treatment of choice for hypophyseal adenomas which form 20 per cent of all brain tumors.

Radiotherapy can produce a permanent cure of these adenomas and the possibility of its being successful is the greater, the earlier treatment is begun.

It is therefore of the utmost importance to make as early as possible a diagnosis, which is based on the finding of bone changes, fundi examination, measurements of the fields of vision, and x-ray examination of the skull. The differential diagnosis is of great importance between hypophyseal tumors which respond to radiotherapy and suprasellar tumors, particularly tumors of Rathke's pouch which are more or less refractory to radiation.

Radiotherapy of hypophyseal adenomata requires the application of medium, periodically divided doses, rather than massive irradiation concentrated over a short period of time.

The most important tumors of the large cranial cavity, excluding the congenital tumors, such as those of Rathke's pouch, and excluding the tuberculomas, syphilomas, metasteses, and several others, are the glioma, (twice as numerous as the hypophyseal adenomas) tumors of intracranial nerves (neuromas) and tumors of the meninges, the meningiomas. Clinical investigation has determined a radiosensitivity only for certain gliomas.

Gliomas with a definite cellular structure, as the medulloblastomas and the multiform spongioblastomas, are the most sensitive to radiation.

Radiotherapy requires the application of strongly penetrating rays which are thoroughly filtered, emitted at a great distance and are directed over large areas from many directions. After an initial test irradiation with a skin dose of 500 R., it is advisable not to exceed a dose of 1000 R. per session in the following sessions, which should at least be forty-eight hours apart. This careful procedure is especially necessary in cases of increased intracranial pressure in which no previous decompression operation was done.

Right and False Application of Radium. Dr. E. Daland. New England J. Med., 1928, p. 1005.

Radium is effective in cavernous angioma, keloids, keratosis of the skin, small bleeding fibroids of the uterus and uterine hemorrhages of unknown cause though the danger of producing artificial menopause must be borne in mind. It is effective in large doses when applied to the skin for myelogenous leukemia, to the glands in lymphatic leukemia and Hodgkin's disease, but the effect is only temporary, and the treatment by x-rays can fully supplant treatment by radium. As a general rule radium should not be applied in malignancies which are operable—healing being attainable only if all parts of the growth can be subjected to destructive doses. On the other hand radium is preferable to surgery in cutaneous cancer of the nose and eye lids for purely cosmetic reasons, but is dangerous in cancer of the lip and all tumors accompanied by metastases, unless the glands too are subjected to treatment. In cancer of the tongue operation takes first, operation with radium second and radium alone third rank. In cancer of the mamma radium is virtually useless, while in cancer of the antrum of Highmore and other sinuses radium should be applied with surgery. In cancer of the gastro-intestinal tract it is also useless except as a palliative; in cancer of the rectum after a primary colostomy. In cancer of the cervix radium is the best available agent, and is to be administered in large doses in favorable cases, while in advanced cases only small doses should be employed. On the other hand radium has a palliative effect only in cancer of the fundus of the uterus. Some good may be expected from radium in cancer of the bladder and prostate in connection with surgical operation.

The author cautions that there is danger in radium treatment if it is given by individuals who have not proper training and experience and concludes with the suggestion that the great expense involved could be solved economically, if hospitals or groups united for the purchase of the valuable agent.

Roentgentherapy of Multiple Sclerosis. K. W. Ipatoff and A. A. Romanowa-Leskowa. Strahlentherapie, 31, 1, 1928.

Roentgentherapy of multiple sclerosis seems to be the only method of treatment of this disease. Roentgentherapy gives results which become manifest only many months, in fact even years after the beginning of treatment. Roentgen irradiation must be done with hard tubes, with a four mm. thickness aluminum ray filter. As a single dose, 25 per cent H. E. D. on the

skin should not be exceeded. It is best to irradiate the entire brain, in order to make sure that foci which are of lesser functional importance are not deprived of the effect of the rays.

Is Roentgen Ray Sensitivity Dependent on the Age of the Cell? Observations in Epilation. H. Holthusen. Strahlentherapie, 31, 1, 1928.

The author reports five observations on three patients in which irradiation with a single dose produced complete epilation of the scalp which had not been irradiated before, whereas that same single dose could not prevent the growth of hair on the scalp which had been epilated by roentgen rays two to three months previously.

The first patient was treated with roentgen rays in the fall of 1925 for a cerebral tumor. At that time an area of six times 8 cm. was exposed to radiation of 156 Kv. and 1 mm. Cu. filter with a dose of 50 per cent H. E. D. At the end of three weeks there resulted complete epilation on the irradiated field. A month later the same region of the scalp, but a larger field (10 times 10), was irradiated with a dose of 70 per cent H. E. D. of the same quality of rays. On March 5th, 1926, the patient was again observed and showed the following findings (photographs in original): On the area irradiated the second time, epilation had only occurred at the periphery where the second area overlapped the boundaries of the area irradiated the first time. In the area irradiated two times a dense growth of hair was present. The same observation was repeated two times on this patient in different parts of the scalp. The author reports the same phenomenon in two other patients.

This phenomenon may be stated as follows: that one to two months after the second irradiation only the field that was irradiated once became epilated, whereas the skin irradiated twice shows a dense growth of hair. This is not the result of the hyperergy caused by the irradiation, but is probably due to a decreased sensitivity of the young hair papillae.

On Paraffin Treatment with Ambrin. Furstenberg and Hoffstaedt. Therap. d. Gegnw., 69, 4, 1928.

Ambrin is a compound obtained from paraffin, to which is added a small amount of neutral resin from South American pines. The material is melted; the odor is not strong nor unpleasant. The melting point is 52 degrees; the solidification point 51 degrees. The diseased part is painted over with the fluid preparation at a temperature of 70 to 75 degrees, centigrade. After the application of several coats of the preparation, a cotton padding is applied, soaked in the fluid mass. This is then covered with cotton and the part is wrapped in flannel. The procedure must be rapid. Local perspiration results. Later the application can be removed like a glove. After that the skin is to have twenty-four hours of rest and care. The fact that paraffin is water free permits the bearing of high temperatures.

Cases of joint, muscle and sciatic diseases were treated successfully. The results were particularly good in acute traumatic effusions and acute infectious processes. Pain disappeared, motion increased. In chronic cases the process was equal to other heat applying procedures. The method showed very good results in a very rebellious case of subacute gonorrheal arthritis. The good results achieved are explained by the long duration of the treatment, so that an equalization of heat occurrs. Locally the deep effect is not very great; there is probably, however, a reflex deep effect.

Blue and Red Light in Dermatology. H. G. Bode. Strahlentherapie, 30, 2, 1928.

The author gathered the results of his clinical experience with the various forms of light as used in over 60 cases. These cases included such diseases as ulcus cruris, sycosis simplex, furunculosis, abscess of the sweat glands, acne vulgaris, herpes zoster, acute eczema, lupus vulgaris, alopecia areata and spina ventosa.

Irradiation was usually done at a distance of 45 cm. and with a final duration of forty minutes, beginning with thirty minutes. The filter was close to the skin. The number of irradiations depended on the individual case. Some were irradiated daily. Irradiation of the diseases mentioned with the possible exception of furunculosis, is without success and superfluous.

An attempt was made to study the manner of action of blue as well as red filtered light by means of mean temperature measurements, and microscopic studies on rabbits as well as man. The result reached was that with similar luminosity of all kinds of irradiation, the heat effect on the circulatory system is the only determinable effectual component. No other effects were determined. In addition, the authors state that red light causes a greater hyperemia as a result of its stronger deep effect.

From their experience with over 60 cases, the authors conclude that results from the use of monochromatic light as an adjuvant in dermatology are to be expected only in furnculosis. There is no indication for the use of this form of therapy in all the other skin diseases mentioned.

The Temperature Coefficient of the Action of Ultraviolet Rays on Ascaris Eggs. A. Dognon and J. C. Tsang. Compt. Rend. Soc. de Biol., Vol. XCVIII, p. 22, 1928.

The temperature coefficient of the effect of ultraviolet rays, expressed by the time necessary to produce a given injury of ascaris eggs is about 1.20 between the temperatures of 16 and 40 degrees. Previously, Dognon had shown that the same coefficient was 2.5 between 20 and 40 degrees, with x-rays of wave length equal to 0.4 U. A., and 2 for x-rays of 0.7 U. A. wave length.

As the temperature coefficient is due to secondary chemical phenomena produced by an initial photochemical effect, one is correct in concluding that the latter is different for x-rays and ultraviolet rays.

Quantitative Measurements in the Visible and Ultraviolet Absorption Spectrum of the Blood and Its Constituents. Third Part: Comparative Measurements of the Blood Cells and Plasma of Various Animals. R. Suhrmann and W. Kollath. Strahlentherapie, 30, 1, 1928.

Absorption measurements were made of the plasma and blood cells of a rat, of the serum of a pigeon and of blood cells of a guinea pig.

The curves obtained for the plasma and serum of the rat and pigeon, respectively, deviate considerably from each other. The deviations are not due to differences in concentrations, but to differences in composition. The blood cells of the rat, guinea pig and man are pretty nearly equal as to violet absorption band. With equal blood pigments there is an increased difference between the curves of rat and man. This is true of the guinea pig in the ultraviolet only. This is similar to the behavior of cholesterin, and should be attributed to a compound of similar structure, which is present in relatively greater amounts in the blood cells of pigeons than in that of man or guinea pigs. The blood cells of man and guinea pig possess almost equal absorption curves and are therefore similarly constituted in regard to the visible and ultraviolet absorbing substances.

The findings speak for a similarity of the blood pigment in the animals studied (rat, guinea pig, man). The known differences of the various hemoglobins are not in the visible but in the ultraviolet absorbing constituents.

The Technic of Application and the Therapeutic Indications of Ultraviolet and Ultra Red Rays. Lobligeois. Prog. Med., Vol. 56, 22, 1928.

The author discusses the physics, apparatus and technic of ultraviolet and infra-red rays, and correlates them with the therapeutic applications. The greatest use of radiation therapy is in pediatrics. In rickets, after consolidation of the bones, actinotherapy is without success. The author stresses the rapidity of the action. He discusses the successful results in spasmophilia, and reports a particularly severe case. The other indications are given in the following order: infantile asthma, depression, anemia, and malnutrition. General and pulmonary tuberculosis are discussed. The author suspects that the sequel of tuberculous meningitis in fever cases is partly due to the use of radiation therapy. However, radiation therapy is very valuable as a prophylactic, by bringing about a resistance against tuberculosis. Excellent results are often seen in localized glandular tuberculosis, with local and general irradiations with ultraviolet rays.

Radiation treatment of tuberculous fistulas is somewhat disappointing. In tuberculous peritonitis, there is a favorable effect on the general and local symptoms. Ascites disappear rapidly, and the fibrinous adhesions are favorably affected, particularly if the ultraviolet radiation is combined with infra-red and roentgen rays. Radiation therapy should only form a part of the treatment. Ultraviolet rays tone up the muscles so that they are indicated in sclicsis as a result of muscle weakness and in the paralyses of children as a supporting measure of the electrical treatment. Heat methods are superior in neuralgias and neuritides. Infrared rays are indicated in wounds and burns. Ultraviolet rays have a remarkable effect in amenorrhea and dysmenorrhea. The author also includes as further indications certain skin diseases, laryngeal tuberculosis, certain diseases of the teeth, trachoma, etc. Radiation therapy should be administered by experienced physicians only.

Ultra Spectrometry of the Blood—a Method for Vitamin Investigation. W. Kollath. Strahlentherapie, 28, 1, 1928.

The ultraviolet absorption of plasma and serum shows considerable differences between human blood and blood of various animals. Rat, guinea pig, pigeon and human bloods were investigated. In scurvy of the guinea pig, the intensity of the absorption around 280 $\mu\mu$ was considerably lowered. The minimum is at 250 $\mu\mu$. A similar relation is shown by scurvy in children (one case). In rat rickets the absorption of ultraviolet light was raised in a solution of blood cells, but lowered in the plasma. In xerophthalmy, in contrast to rickets, both absorption values were lowered. The experimental methods are described in detail. The quantitative methods gave the best results. The author advises to use the blood of sober and hungry individuals.

A New Technic for the X-Ray Diagnosis of Early Pregnancy. G. Albano, Rome. Zentrabl. f. Gynak, 33.

Dr. G. Albano of Rome publishes an interesting method of diagnosing pregnancy in the first and second month. For this purpose the author has administered several contrast agents, combinations of iodo-bromo-strontium, either per os or intravenously. The x-ray pictures show roundish, sharply outlined shadows, corresponding to the amniotic cavity. Fibromata of the uterus, which have been examined for comparison, show shreddy, irregularly outlined contours. The author has found that the best results were obtained from the intravenous injection of sodium tetraiodophenolphthalein, which in proper doses is well tolerated. The picture is best taken half an hour after the injection.

The author has not yet collected any experiences with extra-uterine pregnancy.

Overdosage in Sun and Sea Therapy in Children. G. Barrand. Arch. de Med. d. Enf., 31, 4, 1928.

After a prolonged stay at the sea, some children begin to have headaches, insomnia, lack of appetite, and restlessness at night. These phenomena occur in children who have become well accustomed to their stay at sea. The younger the children are, and the greater the intensity with which the curative factors have been employed, the earlier do these disease symptoms occur, which at times may even be accompanied by a sea fever. The phenomena occur simultaneously

in children who have been exposed to the cure the same length of time. The phenomena are explained by an error in nutrition and particularly by an overdosage in the use of the sea baths. To avoid these complications the author advises to keep the children away from the beach for several days and to reduce the number of baths; at any rate not to give more than 30 baths, even if the stay at the sea shore has to last many months.

A New Method for Measuring the Dosage of Sun Baths. Mezernitzky. Compt. Rend. Acad. d. Sc., Vol. CLXXV, p. 1169, Nov. 21, 1927.

From 60 experiments the author concludes that numerous biological processes (variations of K, Ca, and sugar in the blood, density of the serum, the ph. value, enzymes of the blood, etc.) are very sensitive to variations in the doses of solar energy. An incorrect dosage can cause a considerable injury.

To evaluate a sun bath the author took as the unit the small calory multiplied by cm.^{2} of the surface of the body.

The number of calories falling on 1 cm.^{2} surface perpepndicular to the radiation is estimated every five minutes, by means of Michelson's actinometer. The mean of the numbers found is taken as the result which varies with the clearness of the air and the height of the sun. A formula corrects for the obliquity of the subject toward the solar rays.

The irradiated surface can be deducted from the shadow cast. The tables of dosage are published in the last part of the paper.

Sun and Sky Radiation. F. Linke. Strahlentherapie, 28, 1, 1928.

The article is a review of the present knowledge of sun and sky radiation. For future investigations close co-operation between physicians and physicists, especially meteorologists, is necessary. The physiological effect of the radiation is the product of the intensity of the radiation absorption in the organism and physiological factors. This product must be calculated individually for each wave length and integrated over the entire spectrum. The author gives a mathematical formula for this calculation. The physiological effect of a radiation is not independent of meteorological factors. Radiation has a different effect on a sweating hyperemic skin, that is, in a windless atmosphere, than on a dry, anemic skin such as occurs in a cold, windy atmosphere. The physiological factor related to the amount of cooling must therefore be determined. The psychic effects of light are also to be taken into consideration.

On the Mode of Action of Irradiated Ergosterin in Rickets. A. Hottinger. Naturwissenschaften, 16, 24, 1928.

This is a review article on the present status of the problem of the effect of ergosterin on rickets, late rickets and osteomalacia—diseases which should be considered as belonging to the same group. The author has been able to produce by means of ergosterin changes in the metabolism of healthy individuals which are similar to the characteristic metabolic disturbances in rickets. In rickets the curative effect of ergosterin occurs soon after beginning medication. Calcium metabolism is first normalized and the regulation of the general metabolism follows. The author believes that vitamin D renders innocuous a substance which disturbs calcium metabolism.

Asthma and Tuberculosis in Relation to Climate. W. S. Van Leeuwen. Beitr. z. Klin. d. Tuberk., 68, 6, 1928.

The following knowledge has been gained the past year in relation to asthma: High climate is very good for asthma. Sea shore is relatively good. In the low lands, sand and gravel are good; regions with a high water level and hard soil are bad. The most important climatic factor is the dampness of the walls and floors of homes. The dampness is not injurious in itself but favors the growth of microorganisms. Climate also plays an important role in tuberculosis. Here, too, the high climate, sea coast and dry, sandy regions have been found empirically to be the most favorable.

Bath Therapy in Kidney Disease. P. Saxl. Wien. Klin. Wchnschr., 41, 12, 1928.

Mineral water treatment is contra-indicated on account of the unavoidably great quantity of fluid consumed. Baths and bath curea are especially indicated in acute nephritis. In chronic forms leading to uremia, the value of eliminating solid matter is slight and may even make the disease worse. It is not probable that kidney and skin react alike to thermic stimulation. Climatic cures act favorably in that dry air and heat cause a decrease in edema as well as albuminuria, but miracles should not be expected. Carbon dioxide baths are not suitable for kidney disease. The best results are seen in residual conditions after acute glomerular affections, as well as in nephroses.

Irradiation by Steps. W. Altschul. Strahlentherapie, Vol. 26, Heft. 4, 1927.

The lymphatic glands constitute filters which arrest neoplastic cells and prevent their distant migration. It is important not to injure them before the destruction of the tumor. For this reason the author advises to irradiate a neoplasm in two steps; in the first step the tumor itself is irradiated, covering the glands very carefully. The second time, three to four weeks later, the glands are irradiated.

The Roentgentherapeutic Method in Bronchial Asthma. Strahlentherapie, Vol. 26, Heft. 2, 1927.

The author advises irradiation in the occipital region in the treatment of asthma. The occipital region and the posterior part of the neck are divided into four fields, each field receiving 25 per cent of the erythematous dose, radiation of medium penetration, filtered by 4 mm. of aluminum, and at a focal distance of 22 cm.

With this technic the author has had eight successful results in eight treated cases. According to the author this favorable result of the radiation is due to very complicated processes which can be divided into four groups: depressive action of the rays on the vegetative center, action of the rays on the chlorioid plexus, action of the rays on the skin and action of the rays on metabolism.

The Effect of Hydratic Processes on Metabolism. Lowenstein. Wien. Klin. Wchnschr., 41, 12, 1928.

The basal metabolism as well as the specific dynamic action of proteins were determined before and after certain hydratic procedures in 10 patients suffering from various diseases. The hydrotherapeutic measures were applied every other day so that any previous treatment of the disease had lost its effect, the condition of the patient being explained solely by the effect of hydrotherapy. The favorabde effects of hydrotherapy are attributed by the author to an equalization of the prevailing dysfunction of the vegetative nervous system, in that it has a leveling effect on the processes of that system. Improvement of the diseased condition is accompanied by an equalization of the gaseous interchange.

Cholecystography: an Analysis of 137 Cases Showing the Reliability of the Oral Method. T. Garratt Hardmon. Irish J. M. Sc., Series 6, No. 37, January, 1929.

Following a brief description of the Graham-Cole method, and the technic for the administration of the test material by oral and intravenous routes, the author summarizes his experience in a series of 137 cases. His conclusions are as follows:

The oral method of carrying out the Graham-Cole test is reliable and is capable of giving a correct indication as to whether the gall-bladder is normal or pathological in 93 per cent of cases.

Except in the case of visualized stones it is not possible by means of this test to give a precise diagnosis. Different surgical conditions will produce similar x-ray appearances and therefore in the "no shadow, faint shadow and late appearance cases" one is only justified in saying that the gall-bladder is pathological.

The success of the method depends upon the most careful attention to details in preparation and to correct radiograph technic.

Ultraviolet Wave Lengths Valuable in the Cure of Rickets in Chickens. George H. Maughan. Am. J. Physiol., Vol. 87, No. 2, December, 1928.

Because it is possible that various diseases may be influenced by specific spectral regions, the present problem concerned itself with the effect of specific wave length in rickets. Chickens were selected as the material for study because they are easily handled. They do not depend upon a milk diet in early life, and therefore the food can be controlled from the day of birth. Rickets can be uniformly produced in all the animals. Glass filters were used of various thicknesses and different kind to absorb the spectrum of a quartz mercury vapor arc. A detailed record of observations, tables and methods are included in this report. The conclusion of the author is as follows:

A comparison of different wave lengths as to their power to cure rickets was made by using glass filters capable of absorbing different quantities of the shorter ultraviolet.

After producing rickets in 125 chickens the flock was culled, eliminating the least rachitic and those most affected. Ten groups containing approximately ten chickens in a group were thus obtained. With these the test was conducted.

Those wave length effective in the cure of rickets are in the region between 3130 angstrom units and 2650 angstrom units. Those shorter than 2896 angstrom units seem, from our work, to be relatively weak in this respect; and line 3130 Angstrom units seems to have no curative value.

Careful analysis of the data of this experiment seems to prove conclusively that wave lengths 2968 angstrom units are the most potent in the cure of rickets and that line 3024 angstrom units is perhaps one-fourth as effective.

On Catching Cold and Cold "Infections." K. Harpuder. Deutsch Med. Wchnschr., 54: 15-16, 1928.

Cooling does not necessarily lead to catching cold. There is no known specific pathologic anatomical or path-physiological foundation for chilling. The "cold catching" infections are not a single etiological group, for any of the colds can be caused by other of the factors besides chilling. For catching cold, the weather itself is not as important as the cooling effect. Of great importance is the adaptability of the skin to changes in temperature. Colds constitute injuries to the whole body. The particular organ that is attacked depends on the presence of the disease.

Pure "cold" diseases are for example, coryza, which is usually secondarily infected, neuralgias and muscle rheumatism, in which after injury rheumatic induration occurs as result of lessened solubility of muscle colloids. Pain of the affected muscle is due to hyperalgesia of the affected sensory muscle nerves. Primary chilling of joints and kidney is doubtful, but an existing condition may be made worse by the effects of cold. The albuminuria observed after chilling is caused by a transitory anemia of the kidneys. It has nothing to do with the acute inflammation of the kidneys. In the bladder and intestinal canal, however, there are purely functional disturbances after chilling. The connection between catching cold and infectious diseases has not been explained yet. It has only been demonstrated in pneumonia; it is uncertain in influenza, acute joint rheumatism and meningitis. Numerous experiments in this

connection have demonstrated the existence of a great individual factor.

The results of animal experiments cannot be applied to man. There is very little material showing the results of changes in organs as a result of chilling. Not one of the many theories is satisfactory. The best theory is that of Schade on a colloidal chemistry basis; nevertheless a hypothetical colloidal chemistry basis is substituted for a pure anatomical one. Extensive experimental work is necessary, and not new theories, to clear up the "cold" problem about which little is known.

The Action of the Various Visible Radiations in Biological Photosensitivity. A. Dognon. Vol. XCVIII, p. 21, 1928.

Certain substances, such as eosin and the rose of magdala, possess a sensitizing action even toward radiations situated outside of their absorption band. Thus, for the rose of magdala the yellow ray of the mercury arc lamp, which is not in its absorption band, possesses, with equal absorption, an action which is 50 times greater than the green ray which is strongly absorbed.

This phenomenon does not seem to be general, for the effect of methylene blue is not diminished when placed under light outside of its absorption band.

Treatment of Weak Labor Pains with Diathermy. H. Weitz. Deutsch. Med. Wchnschr. 54, 22, 1928.

After the unsuccessful administration of pituitrin, quinin and hot baths, the birth of a twin (which had died during delivery) was finally brought about by the application of diathermy (dorsoventral application of the electrodes, total duration of fifteen minutes). The first twin was born spontaneously two days before. The bag of waters ruptured the day of delivey. Cervix hardly admitted the finger.

Light Treatment of Erythrocyanosis Crurum Puellaris. A. Perutz. Strahlentherapie, Vol. 29, Heft. 2, 1928.

The author reports eight cases of erythrocyanosis crurum puellaris and discusses its etiology. The affection is to be placed in the group of frost injuries to the skin. Menstrual disturbances are predisposing factors, and cold, dampness and modern female dress (thin material) are exciting factors. Ultraviolet and ultrared irradiation were unsuccessful. Roentgen therapy, however (one-third to one-half E. D.) seemed to be useful in several cases.

The Use of Infra-Red Rays and Diathermy in Gynecology. M. Talewski. Prog. Med., Vol. 56, 10, 1928.

Despite their different physical properties, infrared rays and diathermy have certain similarities in their effect on the organism, such as for instance in their analgesic effect, in the raising of the local temperature, in the increase of local circulation and secretion, and in the increase in tissue vitality. Infra-red rays have an intense deep effect, cause a vaso-dilatation, increase the circulation and improve nutrition of the tissues. The following conditions are given as indications for their use: Salpingitis, metritis, adnexitis, parametritis, oligomenorrhea and amenorrhea. The combination of infra-red irradiation of the ovary region, and general ultraviolet irradiation has given the author good results in the treatment of ovarian insufficiency in young girls. The indications for diathermy, according to Zalewski, are gonorrheal vulvovaginitis, metritis, endometritis, chronic salpingitis, oopheritis, genital hypoplasis in women with dysmenorrhea and amenorrhea. The author describes the different methods of applying diathermy.

Further Observations on the Effects of Irradiated Ergosterin in Animal Experimentation. W. Pfannenstiel. Munchen. Med. Wchnschr. Vol 75, 26, 1928.

The author had already shown, a year ago, that large doses of irradiated ergosterin cause toxic phenomena leading to death in young, healthy rabbits. He attributes these phenomena to a hypervitaminosis. Anoresia, emaciation, diarrhea, and shaggy fur are the symptoms present. A section shows a complete disappearance of fat, even in the inner organs and from the peritoneum and mucous membranes. However, animals which were made artificially rachitic showed no ill effects as a result of overdosage with vigantol. Consequently, only the healthy organism responds with toxic phenomena to the administration of pure vitamin D. The administration of pure vitamin D to healthy adults and to non-rachitic children thus appears not only useless, but directly injurious, a fact which has been confirmed by observations in clinics, an experience which one really has with all effective therapeutic methods.

Therapy of Multiple Sclerosis. Otto Marburg. Jahreskurse f. Arztl. Fortbild., Vol. 19, May, 1928.

The evaluation of any therapy in multiple sclerosis is made difficult in that spontaneous remissions must be taken into account. There are also cases which naturally remain stationary and show no progression. To treat such a case, for example with fever therapy, would be very dangerous, since the latent disease may be stirred up. Parenteral protein therapy may be tried in early cases. Intramuscular yatren casein injections every other day with increasing doses until a total of 90 c.c. is reached have had some success. Mirion has the same effect. Typhoid vaccine treatment, which can be combined with neosalvarsan, has a stronger effect. Care should be used with this method in weak individuals. Nevertheless it should be tried in progressive cases which had already been treated without success. This treatment should be repeated in six months. Antimosin which is injected intragluteally in 5 per cent solution is more effectual. The author has never seen any bad effects and has observed remissions in over

100 cases. This procedure can also be repeated in six to eight months, 2 to 5 c.c. is given every second day and 5 c.c. doses are then given until a total of 90 c.c. is reached. Roentgen therapy can also be tried, particularly in more localized processes.

Measuring the Dose of Ultraviolet Rays. Blumenthal, Franz, and Bohmer. Arch. f. Dermat. u. Syph., 155, 1928.

The quantitative and qualitative measurements of ultraviolet rays is relatively difficult, although it can be done by various methods. Individual differences in sensitivity plays an important role in dosage. The differences are rather large. The erythema time, for example, varies between five and sixty seconds. The general rule that strongly pigmented persons are less sensitive than weakly pigmented persons is not absolutely true. In order to test ultraviolet sensitivity, a number of areas were irradiated through a stencil with many windows, and after twenty-four hours an area which had the contour of the window was determined. Radiation time of this area gives us the measure of sensitivity. The degree of redness can also be determined by erythema measurements.

Physical Problems in Diathermy of Deeply Situated Organs. O. Dieterich. Ztschr. f. Arztl. Fortbild., 25, 8, 1928.

The lead-tin electrodes are not suitable for diathermy because of the strong capillary effect. A part of the failure in practice is due to this factor. The blood stream forms a considerable factor for the production of heat. Very much different relations are obtained in congested organs. To avoid loss of heat it is important to choose, as far as possible, a large electrode. By observing these principles there should be more successful results in diathermy.

Cancer of the Rectum. G. V. Brindley, M. D., F. A. C. S. Southwester Med., 13:1-6, January, 1929.

Case records of 70 patients with cancer of the rectum were reviewed for this study. Justification for this study is due to the frequency of cancer of the rectum, the curability of the early lesions, the hopelessness of advanced disease and the high mortality. Following a review of the cardinal symptoms associated with this disease, the author summarizes the methods of treatment that is most effective in this condition. Cauterization, x-ray, radium are the agencies employed.

His conclusions are:

1. By the use of the cautery, a radical excision of the malignant rectum can be performed with ease and dispatch.
2. There is less bleeding.
3. The field of operation is better visualized.
4. A more extensive growth can be removed.
5. The shock is less frequent and less pronounced.
6. The operative mortality is lowered.
7. The probability of recurrence is definitely diminished.
8. The percentage of permanent cures will be materially increased.

Twelve cases have been operated by this method without a fatality. A majority of the cases has no appreciable degree of shock. In selected cases of low ano-rectal growths, a perineal or vaginal one-stage cautery excision may be performed. Only two cases were operated by this method.

Early cancers located in the recto-sigmoid region sometimes may be removed advantageously entirely through an abdominal approach. The sigmoid and upper rectum are mobilized; the malignant bowel is widely resected; the rectal stump is closed and a permanent colostomy is made. For the more advanced lesions of this part of the bowel, a combined abdomino-sacral technic is used, the second stage of the operation being performed with the cautery.

Colostomy, radium and x-ray are the chief agencies of palliation. Patients with inoperable disease are given radium, particularly for the treatment of the cancerous mass, and x-ray to retard gland metastasis; sometimes these two agencies do much in a palliative way. One patient treated by a colostomy, radium and x-ray, lived a little more than three and one-half years; another, treated by colostomy and x-ray, lived a little more than five years. X-ray therapy is also advocated as a supplement to surgery.

A Statistical Study of Clinical and Laboratory Findings in Gastric and Duodenal Ulcers with Special Reference to Roentgenologic Data. T. G. Miller, E. P. Pendergrass and K. S. Andrews. Am. J. Med. Sc., 177:15-33, Jan., 1929.

The clinical and laboratory data on 279 operatively proved gastric and duodenal ulcer cases, representing a ten years' experience in this hospital, are analyzed, especial attention being given to a selected group of 36 gastric and 100 duodenal cases. The duodenal outnumbered the gastric cases in the ratio of four to one, and it is pointed out that for all of those presenting symptoms the duodenal preponderance is even greater. The male sex predominated in each group (85 to 90 per cent) and the women were on the average a little older than the men. Aside from the roentgenologic findings, the history was of greatest diagnostic importance and sometimes afforded evidence suggesting the gastric or duodenal localization of the lesion. The physical examination was of less diagnostic importance, although the finding of a small spot of epigastric tenderness occurred in almost one-half of the cases and was regarded as of confirmatory value. Both groups of cases showed a tendency to high gastric acidity, more marked in the duodenal, but it is emphasized that such high acidity may occur in individuals free of all evidence of disease and so in itself cannot be accepted as evidence of ulcer.

The roentgenologic findings may be summarized as follows:

1. The roentgenologic diagnosis was correct in 94 per cent of the gastric and 88 per cent of the duodenal ulcers.

2. The most important roentgenologic diagnostic sign was the filling defect.

3. In 23 cases, that were diagnosed either pyloric stenosis, gastro-duodenal ulcer, or pyloric obstruction, only six ulcers seemed to be pyloric in origin, the others being distinctly duodenal.

4. Healed ulcers give similar defects to adhesions or ulcers, but do not have associated suggestive fluoroscopic phenomena.

Some Remarks on Roentgenotherapy in Inoperable Epithelioma of the Face. G. Scaduto. Urol. & Cutan. Rev., 38:28-32, Jan., 1929.

Roentgenotherapy of cutaneous epithelioma is now no longer considered a doubtful procedure. Epithelioma of the baso-cellular type are considered as being radiosensitive and those of the squamo-cellular type are radio-negative. Although the above statement is generally accepted by the medical world, the author believes that the spino-cellular (squamo-cellular) type of epithelioma may also be cured by roentgen rays. In the past ten years the author has treated more than 2,000 cases of epithelioma successfully. In order to effect the best results, the roentgenologist should investigate and find the original cause of the malignancy, or the condition in the patient which may have favored it.

Injury Resulting from Radiation in Basedow's Disease. K. Goette (Heidelberg). Band XXXIX Ausgegeben, Jan., 1929, Heft 1 Fortschritte auf dem gebiete der Roentgenstrahlen.

A consideration of the course of two cases of moderately severe Basedow's disease, which after radiation (1/4 Hed., the other twice, 1/10 Hed.) became consederably worse and died with the symptoms of hyperthyroidism. The aggravation of symptoms must be attributed to the radiation. Radiation therapy also as surgery in true Basedow's disease, is not without risk .

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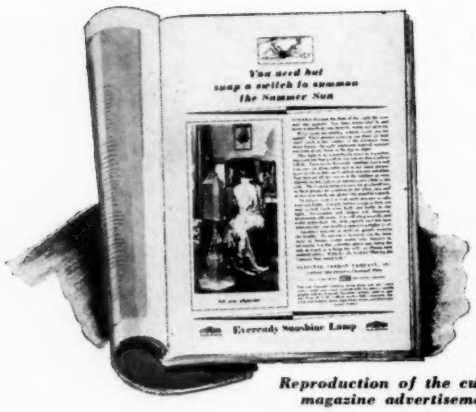

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